Part Number 2120-0140

MODEL DQ152

MAGNETIC TAPE COUPLER

INSTALLATION AND OPERATION MANUAL

PRELIMINARY

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DISTRIBUTED LOGIC CORPORATION
1555 S. Sinclair Street
P.O. Box 6270
Anaheim, California 92806
Telephone: (714) 937-5700
Telex: 6836051

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DESCRIPTION

INTRODUCTION

This manual describes the installation, operation, and programming of Distributed Logic Corporation (DILOG) Model DQ152 Magnetic Tape Coupler. The coupler interfaces DEC* MicroVAX II, MICRO PDP-11, and LSI-11 Q-bus based computer systems to Pertec Industry-Standard formatted magnetic tape drives. The complete coupler occupies one dual module in the backplane. The coupler emulates DEC TS11, TU80, and TSV05 tape subsystems.

COUPLER CHARACTERISTICS

A magnetic tape subsystem consists of a coupler, a formatter and one tape drive. The function of the coupler is to buffer data and status between the I/O bus and the formatter and to transfer commands from the I/O buffer to the formatter. The formatter, which is embedded in the drive, establishes the data format, controls tape motion, and performs error checking. The overall tape control function is a combination of the coupler functions, which are related to the LSI-11, and formatter functions, which are related to the tape drive.

Figure 1-1 is a simplified diagram of a magnetic tape system.

A microprocessor is the sequence and timing center of the coupler. The control information is stored as firmware instructions in Read Only Memory (ROM) on the coupler board. One section of the ROM contains a diagnostic program that tests the functional operation of the coupler. This self test is performed automatically each time power is applied or whenever a diagnostic command is issued. A red diagnostic indicator on the board lights to indicate diagnostic or command activity, or flashes a 5-bit (MSB first) error code if self test fails. During self test, the LED will alternate ON and OFF every seven seconds. If self test fails, the coupler has an automatic data feature that stops the computer from interacting with the tape formatter and thus prevents writing erroneous information into critical data base areas.

LSI-11 Q-BUS INTERFACE

Commands, data and status transfers between the coupler and the computer are executed via the parallel I/O bus (Q bus) of the computer directly to memory, via the DMA facility of the Q bus. Coupler/Q Bus interface signals are listed in Table 1-1.

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* DEC is a registered trademark of Digital Equipment Corporation.

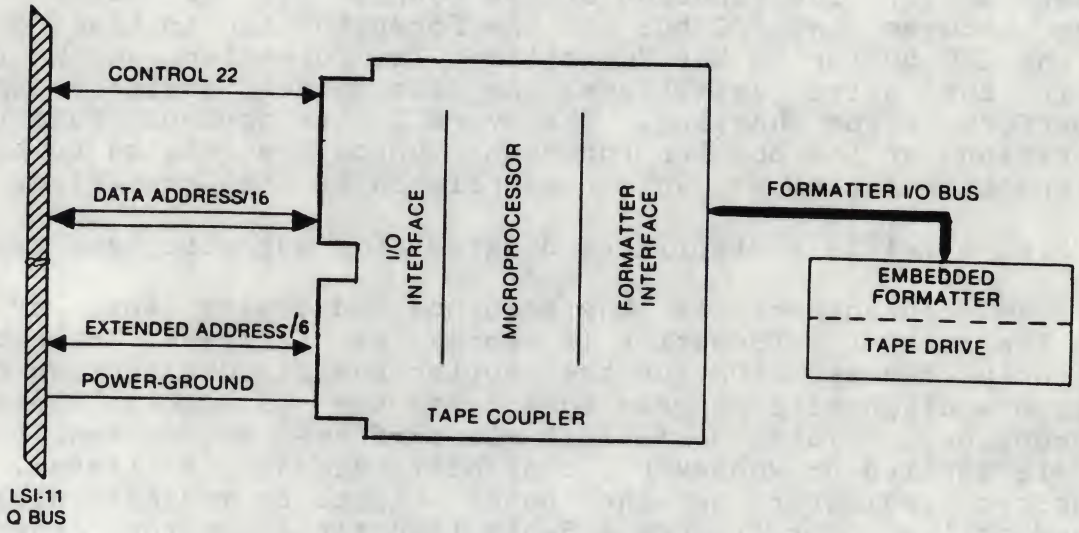


Figure 1-1. Tape System Configuration

Table 1-1. Coupler/Q-Bus Interface Lines (Dual Module)

BUS PIN	MNEMONIC	INPUT/ OUTPUT	DESCRIPTION
AJ1, AM1, BJ1, BM1, BT1, BC2	GND	O	Signal Ground and DC return.
AN1	BDMR L	O	Direct Memory Access (DMA) request from controller: active low.
AP1	BHALT L	N/A	Stops program execution. Refresh and DMA is enabled. Console operation is enabled.
AR1	BREF L	N/A	Memory Refresh and Block Mode DMA Slave Signal
BA1	BDCOK H	I	DC power OK. All DC voltages are normal.
BB1	BPOK H	I	Primary power OK. When low activates power fail trap sequence.
BN1	BSACK L	O	Select Acknowledge. Interlocked with BDMGO indicating controller is bus master in a DMA sequence.
BR1	BEVNT L	N/A	External Event Interrupt Request.
BV1, AA2, BA2,	+5	I	+5 volt system power.
AD2, BD2	+12	I	+12 volt system power. (Fused to External Connector)
AE2	BDOUT L	I/O	Data Out. Valid data from bus master is on the bus. Interlocked with BRPLY.
AF2	BRPLY L	I/O	Reply from slave to BDOUT or BDIN and during IAK.
AH2	BDIN L	I/O	Data Input. Input transfer to master (states master is ready for data). Interlocked with BRPLY.
AJ2	BSYNC L	I/O	Synchronize: becomes active when master places address on bus; stays active during transfer.
AK2	BWTBT L	I/O	Write Byte: indicates output sequence to follow (DATO or DATOB) or marks byte address time during a DATOB.
AL2, AA1, AB1, BP1	BIRQ4-7 L	O	Interrupt Request 4-7.
AM2 AN2	BIAK1I L BIAK1O L	I O	Serial Interrupt Acknowledge input and output lines routed from Q Bus, through devices, and back to processor to establish an interrupt priority chain.
AT2	BINIT L	I	Initialize. Clears devices on I/O bus.
AU2, AV2, BE2, BF2, BH2, BJ2, BK2, BL2, BM2, BN2, BP2, BR2, BS2, BT2, BU2, BV2	BDAL0 L through BDAL15 L	I/O	Data/address lines, 0-15.
AR2 AS2	BDMG1I L BDMG1O L	I O	DMA Grant Input and Output. Serial DMA priority line from computer, through devices and back to computer.
AP2	BBS7 L	I	Bank 7 Select. Asserted by bus master when address in upper 4K bank is placed on the bus.
AC1, AD1, BC1, BD1, BE1, BF1	BDAL 16 L -BDAL21 L	O	Extended Address Bits 16-21

FORMATTER INTERFACE

The coupler interfaces with the formatted tape drives through two 50-pin flat cable connectors at the top of the coupler board. The maximum cable length between coupler and formatter is 20 feet. Coupler/formatter interface signals are listed in Tables 1-2 and 1-3. At the formatter end of the cable, the card edge connectors are AMP 88373-1 (or equivalent). The keying-pin adapter for these conectors is AMP 88113-1 (or equivalent). At the coupler end the connectors are 3M 3425-6050 (or equivalent).

Table 1-4 lists tape drive manufacturers and connector correlations.

COUPLER SPECIFICATIONS

Data Format

- Industry standard non-return-to-zero (NRZ), Phase Encoded (PE), or Group Coded Recording (GCR) recording.
- 9 tracks.
- Recording densities:
  800 characters per inch (NRZ)
  1600 characters per inch (PE)
  3200 characters per inch (PE)
  6250 characters per inch (GCR)
- Inter-record Gap (IRG) = 0.50 inch minimum (NRZI/PE) or 0.30 inch minimum (GCR).

Media Characteristics

- Type:
  1/2" wide mylar base, oxide coated, magnetic tape.

- Reel Size:
  7", 8-1/2", or 10-1/2" diameter tape reels containing 600, 1200, and 2400 feet of tape, respectively.

- Data Capacity (megabytes):
  Assumes approximately 80% recording efficiency:

		800 CPI	1600 CPI	3200 CPI	6250 CPI
600 Ft.	=	5.75	11.5	23.0	
1200 Ft.	=	11.5	23.0	46.0	
2400 Ft.	=	22.0	44.0	88.0	172.0

- Data Transfer Rate (Characters/Second):

		800 CPI	1600 CPI	3200 CPI	6250 CPI
12.5 ips	=	10,000	20,000	40,000	
25.0 ips	=	20,000	40,000	80,000	
37.5 ips	=	30,000	60,000	120,000	
45.0 ips	=	36,000	72,000	144,000	280,000
75.0 ips	=	60,000	120,000	240,000	470,000
125.0 ips	=	100,000	200,000	400,000	780,000
200.0 ips	=	160,000	320,000	640,000	1,250,000

Emulation:

- TS11, TU80, TSV05

Hardware Bootstrap:

- Onboard bootstrap support for TS11, TU80, TSV05; jumper-selectable addresses and Enable/Disable.

Register Address:

- Data/Address Buffer (TSDB/TSBA) 772 520*
- Status (TSSR) 772 522*
- Extended Data Buffer (TSDBX) 772 523*

*Alternate addresses are software selectable.

Computer I/O Interface:

- Interrupt Vector Address 224. Alternate Addresses are software selectable.
- Priority Level BR4 (BR5, BR6, BR7 are software selectable).
- DMA data transfers, block or non-block mode automatically selected: burst size and dwell time software selectable.
- Packet Processing type programming.
- One std. DC bus load.

Addressable Memory:

- Software selectable 18 or 22 bits (4.0 MB).

Coupler Formatter Interface:

- The coupler is compatible with tape formatters manufactured by CDC, Cipher, Digi-Data, Kennedy, Pertec, S.E. Labs, Thorn Data, STC, Fujitsu, Megatape, and Telex.

Packaging:

- The coupler is completely contained on one dual module 5.22 inches (13.2 cm) by 8.88 inches (22.55 cm).

Documentation:

- One Installation and Operation Manual is supplied with the coupler.

Power:

- +5, +0.25 VDC at 2.5 amps, from computer backplane.

Environment:

- Operating temperature 50 deg. F (10 deg. C) to 104 deg. F (40 deg. C). Operating humidity 10% to 95% non-condensing.

NOTE: The quality of recording and reading information on magnetic tape is affected by temperature and humidity. The environment where the tape is used should be maintained within the following limits:

Ambient Temperature: 60 deg. F (15 deg. C) to 85 deg. F (32 deg. C)
Humidity: 20% to 80% non-condensing

Shipping Weight:

- Two pounds including documentation.

Table 1-2. Coupler Connector J1 to Formatter Interface Lines

J1 Signal	J1 Return	Mnemonic	Description
2	1	FFBY	Formatter Busy
4	3	CLWD	Last Word
6	5	CWD4	Write Data 4
8	7	CGO	Initiate Command
10	9	CWD0	Write Data 0
12	11	CWD1	Write Data 1
14	13	FDCK	Drive Check
16	15	CLOL	Load on Line
18	17	CREV	Reverse/Forward
20	19	CREW	Rewind
22	21	CWDP	Write Data Parity
24	23	CWD7	Write Data 7
26	25	CWD3	Write Data 3
28	27	CWD6	Write Data 6
30	29	CWD2	Write Data 2
32	31	CWD5	Write Data 5
34	33	CWRT	Write/Read
36	35	CRTH2 (FLGAP)	Density Select
38	37	CEDIT	Edit
40	39	CERASE	Erase
42	41	CWFM	Write File Mark
44	43	CRTH1	Gap Length
46	45	CTAD0	Transport Address 0
48	47	FRD2	Read Data 2
50	49	FRD3	Read Data 3

Note: () Parentheses are applicable to streaming and GCR drives.

The "C" prefix indicates signals to the tape drive;
The "F" prefix indicates signals from the tape drive.

Table 1-3. Coupler Connector J2 to Formatter Interface Lines

J2 Signal	J2 Return	Mnemonic	Description
1		FRDP	Read Data Parity
2		FRD0	Read Data 0
3		FRD1	Read Data 1
4		FLDP	Load Point
6	5	FRD4	Read Data 4
8	7	FRD7	Read Data 7
10	9	FRD6	Read Data 5
12	11	FHER	Hard Error
14	13	FFMK	File Mark
16	15	FCCG/ID	CCG/IDENT
18	17	CFEN	Formatter Enable
20	19	FRD5	Read Data 5
22	21	FEOT	End of Tape
24	23	COFL	Offline
26	25	FNRZ(FGOR)	NRZI (GCR) status
28	27	FRDY	Ready
30	29	FRWD	Rewinding
32	31	FFPT	File Protect
34	33	FRSTR	Read Strobe
36	35	FWSTR	Write Strobe
38	37	FDBY	Data Busy
40	39	(FHSPD)	High Speed Status
42	41	FCER	Corrected Error
44	43	FONL	Online
46	45	CTAD1	Transport Address 1
48	47	CFAD	Formatter Address
50	49	CDEN(FHISD)	Speed Select

Note: () Parentheses are applicable to streaming and GCR drives.

The "C" prefix indicates signals to the tape drive;
The "F" prefix indicates signals from the tape drive.

Table 1-4. Coupler to Formatter Connection Correlation

Coupler Connector J1 to:		
Manufacturer	**Model**	**Connector**
CDC	Keystone 92181	J4
CDC	Keystone 92185	J2
Cipher	F880	P1
	F100X, F900X (Adapter required)	P4
Digi-Data	Formatted	JC
IDT	1012	J1
	1050	J124
Kennedy	6809 Streamer	J1
	Formatted	J5
Pertec	Formatted (Embedded)	P4
	External Formatter (Adapter required)	P4

Coupler Connector J2 to:		
Manufacturer	**Model**	**Connector**
CDC	Keystone 92181	J5
CDC	Keystone 92185	J3
Cipher	F880	P2
	F100X, F900X (Adapter required)	P5
Digi-Data	Formatted	JD
IDT	1012	J2
	1050	J125
Kennedy	6809 Streamer	J2
	Formatted	J1
Pertec	Formatted (Embedded)	P5
	External Formatter (Adapter required)	P5

SECTION 2

INSTALLATION

INSPECTION

The padded shipping carton that contains the coupler board also contains an installation and operation manual and cables to the magnetic tape drive (if this option is exercised). The coupler is completely contained on the dual-size printed circuit board. The drive, if supplied, is contained in a separate shipping carton. Inspect the coupler and cable(s) for damage.

CAUTION

If damage to any of the components is noted, do not install. Immediately inform the carrier and DILOG.

Installation instructions for the tape drive are contained in the tape drive manual. Before installing any components of the magnetic tape system, read Sections 1, 2, and 3 of this manual. Figure 2-1 illustrates the configuration of the coupler.

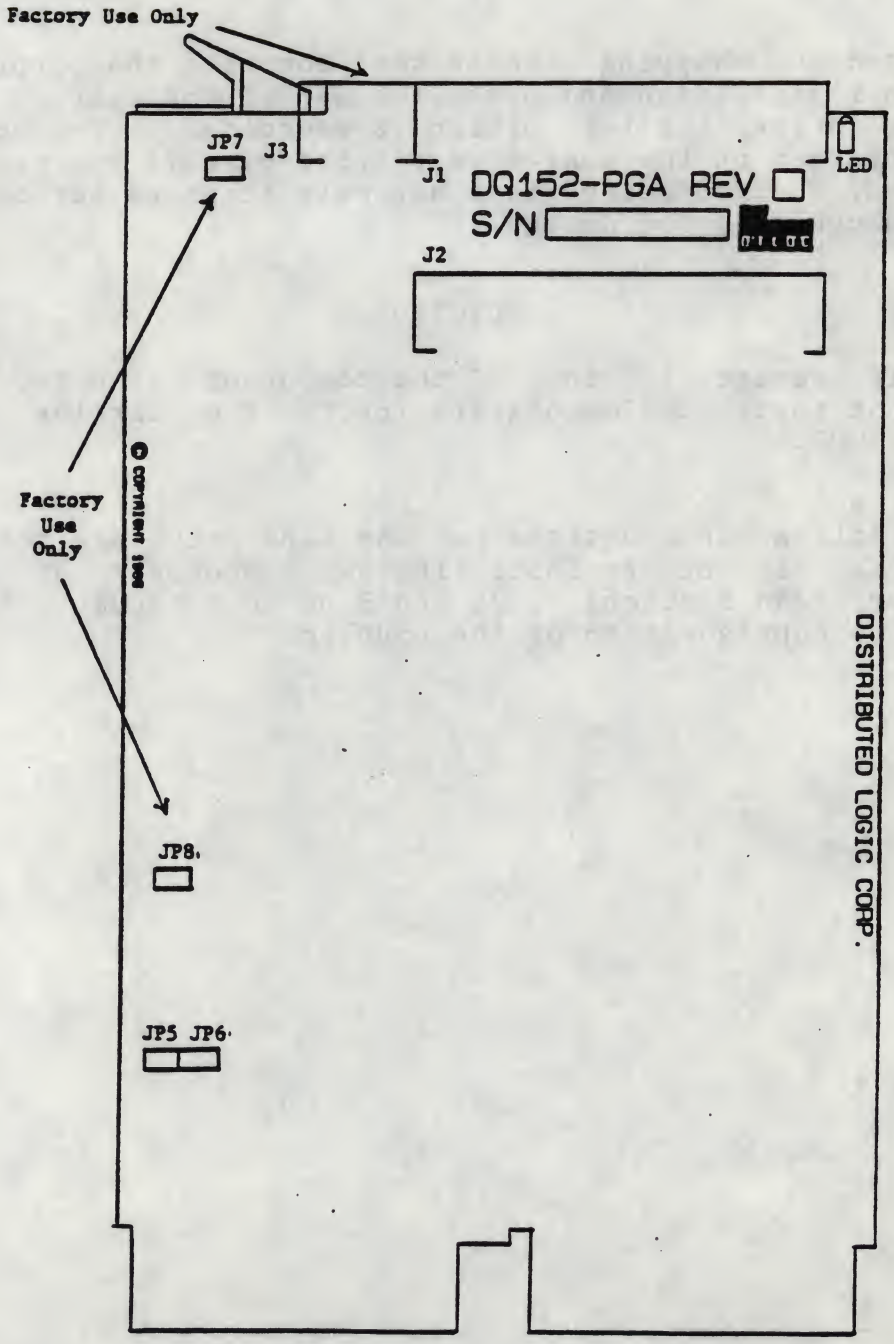


Figure 2-1. Coupler Configuration

INSTALLATION

To install the coupler module, proceed as follows:

CAUTION

Turn power OFF on the computer before inserting or removing the coupler module.
Damage to the backplane assembly may occur if the coupler module is plugged in backwards.

1. Select the backplane location into which the coupler is to be inserted.

   There are several backplane assemblies available from DEC and other manufacturers. Figures 2-2 and 2-3 show typical backplane configurations. Note that the processor module is always installed in the first location of the backplane or in the first location in the first backplane of multiple backplane systems.

   All slots of the backplane of Q-bus based computers are not wired the same. With the introduction of the Micro/PDP-11 and the MicroVAX, the first three, and sometimes four (depending on the backplane), slots of the backplane make the C and D rows available for customer-defined signals or for the Private Memory Interconnect (PMI) bus in MicroVAX systems (see Figures 2-2 and 2-3). These first few slots are termed Q/CD slots. In most older Q-bus based systems, the A/B and C/D slots were all wired the same so that two dual-height modules could be installed in a quad-height bus slot (these are called Q/Q backplanes). If the coupler is installed in one of the Q/CD slots, it must be installed in the A/B rows--no grant continuity card is required. If the coupler is installed in one of the Q/Q slots, it can be installed in either the A/B or C/D rows; however, the opposite rows must contain either another dual-height module, a DEC M9047 grant continuity card (MicroVAX), or G7272 grant continuity card (Micro PDP-11).

NOTE

The type of slot--Q/Q or Q/CD in the MicroPDP-11 or MicroVAX chassis--is identified by a label adjacent to the backplane slot in the chassis.

2. Refer to the paragraph in this Section entitled, "Hardware Bootstrap PROM." Jumpers on the coupler enable or disable an onboard bootstrap PROM and also select one of two bootstrap addresses. The coupler is shipped with the bootstrap PROM enabled and address 175 000 selected. Either disabling the PROM or selecting the alternate address must be done before the coupler can be installed. For MicroVAX II systems, the bootstrap must be disabled.

3. Insert the coupler into the selected backplane position. Be sure the coupler is installed with the components facing row one, the processor.

   The coupler module is equipped with a handle on the side opposite the slot connectors. Gently position the module slot connectors into the backplane then press the handle until the module connectors are firmly seated into the backplane.

4. Feed the module connector end of the tape drive cable(s) into the coupler module connector(s). Install the cable connector(s) into the module connector(s). Verify that the connector(s) are firmly seated.

5. Connect the drive end of the I/O cables to the drive I/O connectors.

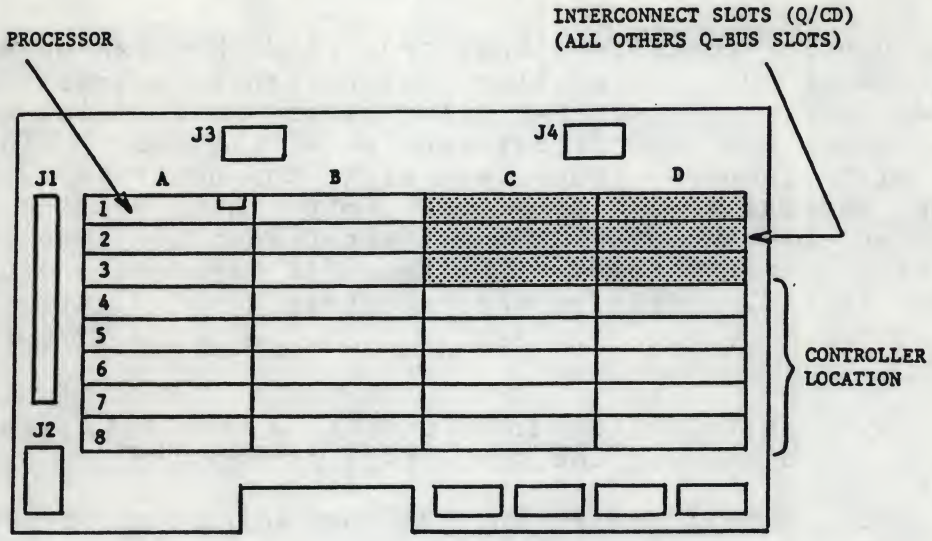
6. Refer to the magnetic tape manual for operating instructions and apply power to the drive and computer.

7. Observe that the red diagnostic LED on the coupler board is alternating ON and OFF about every seven seconds.

8. Refer to the paragraph in this Section entitled, "Configuring the Coupler." This paragraph describes how to modify factory-set parameters, such as coupler address, interrupt vector address,

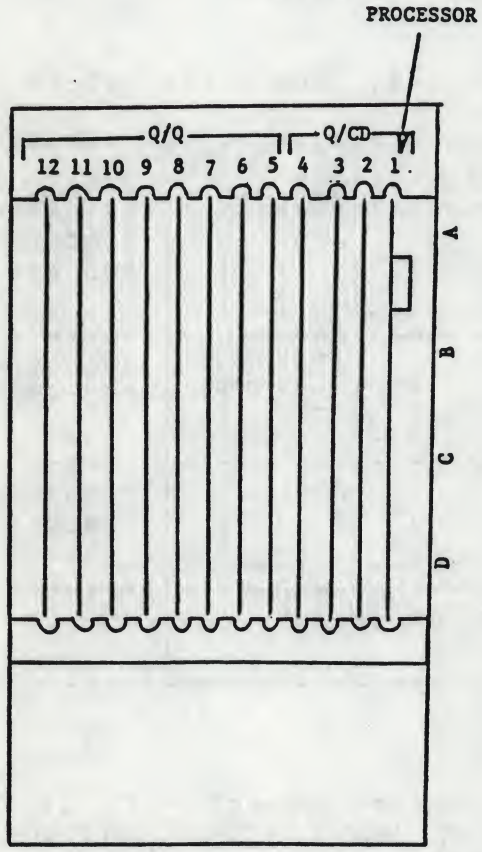
   etc., if required by the system configuration.

9. The system is now ready to operate. Refer to Section 3 for operating instructions.



NOTE: Components on the board must be facing towards the Processor.

Figure 2-2. MicroVAX II H9278 Backplane



NOTE: Components on the board must be facing towards the Processor.

Figure 2-3. MicroVAX II Backplane (Typical)

HARDWARE BOOTSTRAP PROM

The coupler contains a bootstrap PROM that can be enabled or disabled by jumper JP5. If enabled, the bootstrap address can be changed by jumper JP6. Figure 2-1 illustrates the location of the jumpers. Table 2-1 shows the jumper position possibilities. The coupler is shipped with jumpers installed with the bootstrap PROM enabled and bootstrap address 175000 selected. Note that booting can also be accomplished by entering the bootstrap routines described in Section 3, "Operation." Installation in MicroVAX systems requires removing the jumper in JP5, disabling the bootstrap.

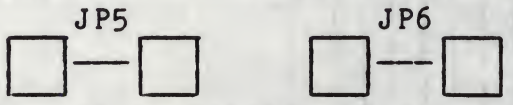
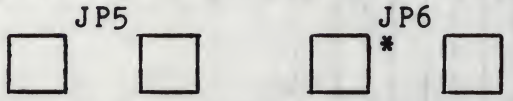
NOTE

1. Installation in MicroVAX II systems requires disabling the bootstrap; remove JP5.

2. With JP5 removed, JP6 jumpering has no effect on coupler operation.

3. If jumper(s) are removed, it is recommended that the jumper(s) be rotated 90 degrees for storage to prevent loss, i.e., install with one jumper pin inserted over only one pin of the jumper location.

Table 2-1. Bootstrap Select Jumpers

JUMPER CONFIGURATION	BOOTSTRAP
	Bootstrap Enabled Address 173000
	Bootstrap Enabled Address 175000
	Bootstrap Disabled: JP5 removed (Default)
* Jumper can be in or out.	

RS232 Connector

Adjacent to Formatter Connector J1 is RS232 connector J3. By plugging optional DILOG Model 53132 paddleboard into J3, a terminal can be plugged directly into the coupler board and the coupler configured offline from the processor. 53132 connector J1 plugs into coupler connector J3; the console terminal cable plugs into 53132 connector J2. Note that before terminal communications can be initiated, a bus INIT must be generated.

NOTE

The positions of the switches and jumpers on the 53132 are not pertinent to the operation of the 53132 as a terminal port; the are used by factory personnel during production test.

The terminal must be configured as follows:

- 9600 Baud
- 8 Data Bits
- No Parity Bit
- One Stop Bit

CONFIGURING THE COUPLER

Except for enabling or disabling the coupler bootstrap PROM and selecting the bootstrap address (see preceding paragraph), all other user-selectable parameters which configure a magnetic tape subsystem to meet specific requirements are selected via a virtual terminal (the system console). This permits the user to modify parameters without removing the coupler board from the system. This "software configuration" technique eliminates all switches and most jumpers from the coupler board, which simplifies changing more frequently modified parameters.

Virtual terminal parameter selection is made possible by a non-volatile RAM (NOVRAM) contained on the coupler. The NOVRAM stores the coupler parameters and contains a configuration menu that is "brought up" (displayed) on the virtual terminal screen when requested by the user. The configuration menu comprises a "main" menu from which four selections may be made: two of the selections initiate diagnostic tests and the remaining two selections permit the user to either display or set coupler characteristics (parameters).

At the present time, 11 coupler parameters may be modified by the user using the virtual terminal. All parameters are factory-set at delivery to default values which, through experience, have been selected to meet the needs of the vast majority of users of magnetic tapes in their computer systems. When parameters need to be changed, typically only three or four of the 11 are involved:

A. TSDB/TSBA register address,
B. Interrupt vector address,
C. TS11 or TSV05 (extended features) compatibility.

The remaining parameters might need to be modified under special systems applications (real-time data acquisition), when a system is heavily loaded with I/O devices, or when newer tape drives with improved features become available.

The following paragraphs describe initiating communications via the virtual terminal, bootstrapping, and displaying/setting coupler parameters. A detailed description of the coupler parameters, the effect of the modification of parameters on tape subsystem operation, are contained at the end of this Section. This information is provided primarily for the use of maintenance personnel or for users that need to modify parameters to meet specific computer systems requirements.

Note that in the following discussions:

A. All addresses are in octal form unless otherwise indicated.
B. In the example user/terminal dialog, characteristics underlined are output by the system; characters not underlined are input by the operator.
C. Throughout the following material, the words "coupler" and "controller" are used interchangeably and have the same meaning.

Initiating Communications for LSI Systems Via Virtual Terminal

The system console is used as the terminal for serial communication. In order to initiate communication via the virtual terminal, the system console must first be placed in the ODT (Online Debugging Technique) mode.

If the bootstrap PROM on the coupler is enabled, a boot must be initiated by typing on the system console either 777775000G or 777773000G, depending on which boot address is selected on the coupler (see paragraph on hardware jumpers for details on boot address selection). The system console will respond with an "*" as a prompt. At this point, the user can respond to the prompt in two ways. The user can either type "MS," which will tell the coupler to attempt a boot from a bootable tape, or "FT," which will bring up the configuration menu.

NOTE

When making a selection, capital letters must be used.

For example, if the bootstrap is enabled and the boot address is 175000, proceed as follows (enter):

@ 7775000G

*

(If the bootstrap address is 173000, enter 7773000G.)

If the boot on the coupler is disabled, communication via the virtual terminal can be initiated by typing 77777 to the TSDB address (TSDB default address = 172520) followed by a carriage return. The user must then type 2000G. The system console will respond with an "*" as a prompt. The user then has the option of typing either "MS" or "FT" (the same options as described above).

NOTE

This procedure will work regardless of whether the boot address of the coupler is enabled or disabled.

For example, if the TSDB/TSBA address is 172520 (TSSR is 172522), proceed as follows:

@ 17772522/0 <CR>

@ 17772520/000000 77777 <CR>

@ 2000G

*

Note that the coupler not only supports standard DEC devices during the bootstrap procedure, but also allows the use of the onboard configuration menu in NOVRAM. When "MS" is used, the standard DEC emulation is called. When "FT" is used, the onboard configuration menu is brought up for display and use via the system console. For example:

```
*    Enter one of the following: DM0,  DP0, DL0,  DR0, MS0, MT0,
     DY0, DU, or FT  <CR>

     Definitions are as follows:

     DM = RK06/07 Disk
     DP = RP02/03 Disk
     DL = RL01/02 Disk
     DR = RM03/05/80 Disk
     MS = TS11 Tape
     MT = Tape
     DY = RX02 Floppy Disk
     DU = DU Emulation
     FT = Enable onboard configuration menu through system
          console
```

Initiating Communications Via Virtual Terminal for MicroVAX Systems

In order to initiate communication via the virtual terminal, the system console is used for serial communication. Note that the bootstrap PROM must be disabled: JP5 removed.

Upon powering up the MicroVAX II, the user must set up the MicroVAX II I/O map via the system console; type 3FFF hex to the TSDB address (TSDB default address = 172520) and start executing code at location 200 hex. This is done as shown in Table 2-2. After executing this procedure the configuration menu is displayed on the system console.

Table 2-2. Procedure to Initialize the Virtual Terminal Via MicroVAX II

```
>>>D/P/L 20088004 80000001 <CR> <---- Setup MicroVAX II I/O map (hex
                                      notation)
>>>D/P/W 20001F40 20 <CR>       <---- Setup MicroVAX II I/O map (hex
                                      notation)
>>>D/P/W xxxxxxxx 3FFF <CR>     <----- Deposit 3FFF hex in TSDB ad-
                                       dress.  The values of xxxxxxxx
                                       are hex values of the control-
                                       ler address of the TSDB regis-
                                       ter and are listed in Table 2-5
>>>S 200 <CR>                   <---- Start executing code at 200 hex
```

(At this point the configuration menu should be displayed.)

CONFIGURATION MENU

Upon entering the coupler's onboard configuration menu, the following will be displayed:

```
        Configuration Menu
----------------------------
1 - STANDARD DIAGNOSTICS
2 - HOST Q-BUS MEMORY - DMA TEST
3 - DISPLAY CONTROLLER CHARACTERISTICS
4 - SET CONTROLLER CHARACTERISTICS

Enter a selection:
```

Any of the four selections may be entered at the prompt by simply typing the number that corresponds to the desired selection, followed by a carriage return.

The first selection, STANDARD DIAGNOSTICS, enables the coupler to run its onboard diagnostics. Each time a diagnostic test is successfully passed, a "." will be printed on the screen. It takes approximately seven seconds for the coupler to make one pass through all the diagnostic tests. The coupler will continue to loop on the diagnostic tests until a CTRL C (^C) is typed on the terminal. (Notice that the coupler does not respond immediately to the ^C when in the virtual terminal mode. It takes several seconds for the coupler to respond, so please be patient.)

Upon recognizing the ^C, the coupler will return to the configuration menu. If an error is encountered during the execution of a diagnostic test, an "E" will be printed on the screen and the onboard LED will flash the appropriate error code (see documentation on error code flashing for details, Table 3-3). The coupler will conduct a loop on error process until either a ^C is detected or a power on reset is conducted.

The second selection, HOST Q-BUS MEMORY - DMA TEST, enables the coupler to conduct DMA transfers to and from the host system.

CAUTION

THIS TEST WILL WRITE ALL OF HOST MEMORY--THEREFORE, ANYTHING RESIDING IN HOST MEMORY WHILE THIS TEST IS BEING CONDUCTED WILL BE OVERWRITTEN!!

This test verifies that data written to and read from the host is valid to ensure that operations between the host and the coupler are functioning properly.

NOTE

This test will not be executed if operating in virtual terminal mode.

The third and fourth selections enable the user to configure the coupler. For details, see the "Displaying Coupler Characteristics" and "Setting Coupler Characteristics" paragraphs of this Section.

Display Coupler Characteristics

Selection 3 of the configuration menu allows the user to display on the terminal the current coupler characteristics as determined by current settings in the coupler NOVRAM. Selection 3 displays the following:

```
Display Controller Characteristics
----------------------------------
TSDB/TSBA Address:                                          [xxxxxx]
Dwell Count (Count x 270 nsec = Dwell Time):                [xxx]
Burst Size:                                                 [xxx]
Interrupt Vector:                                           [xxxxxx]
Interrupt Priority:                                         [xx]
Extended Features:                                          [x]
Offline Immediate (Typ. * Disabled)                         [x]
Force Read Threshold 2 On (J1-36 RTH2 - Typ.*
    Long Gap):                                              [x]
Force Read Threshold 1 On (J1-44 RTH1 - Typ.*
    Density Select):                                        [x]
Force Density On (J2-50 DEN - Typ.* High Speed):            [x]
64KB Record Timeout Count:                                  [xxx]
Blank Tape Timeout Count:                                   [xxx]

          ** ** ** Press <CR> to continue ** ** **
```

* Typ. = Typical of Pertec interface. Other tape drives may have different signal definitions for these lines.

As seen above, A) the TSDB/TSBA address, B) the dwell time and burst size for DMAs, C) the coupler's interrupt vector and priority to the host, and D) tape control options are displayed. The x's in the above list represent the current value of each coupler characteristic. All of the values are given in octal form. After displaying the coupler characteristics, typing a carriage return, <CR>, will display the configuration menu again.

Below is a list of the default values of the coupler configuration characteristics.

	DEFAULT VALUE
TSDB/TSBA Address:	[172520]
Dwell Count (Count x 270 nsec = Dwell Time):	[004]
Burst Size:	[010]
Interrupt Vector:	[000224]
Interrupt Priority:	[04]
Extended Features:	[Disabled]
Offline Immediate (Typ. * Disabled)	[Disabled]
Force Read Threshold 2 On (J1-36 RTH2 - Typ.* Long Gap):	[Disabled]
Force Read Threshold 1 On (J1-44 RTH1 - Typ.* Density Select):	[Disabled]
Force Density On (J2-50 DEN - Typ.* High Speed):	[Disabled]
64KB Record Timeout Count:	[014]
Blank Tape Timeout Count:	[116]

* Typ. = Typical of Pertec interface. Other tape drives may have different signal definitions for these lines.

Set Coupler Characteristics

Selection 4 of the configuration menu allows the user to set the coupler characteristics (i.e. set up the NOVRAM). Selection 4 displays the following:

```
Set Controller Characteristics
------------------------------
[ ] = current configuration, <CR> = default to current setting

     TSDB/TSBA Address:                          [xxxxxx]  {user response}
     Dwell Count (Count x 270 nsec =
          Dwell Time):                           [xxx]     {user response}
     Burst Size:                                 [xxx]     {user response}
     Interrupt Vector:                           [xxxxxx]  {user response}
     Interrupt Priority:                         [xx]      {user response}
     Extended Features:                          [x]  (E/D) ? {user resp.}
     Offline Immediate (Typ. * Disabled)         [x]  (E/D) ? {user resp.}
     Force Read Threshold 2 On (J1-36
          RTH2 - Typ.* Long Gap):                [x]  (E/D) ? {user resp.}
     Force Read Threshold 1 On (J1-44
          RTH1):  - Typ. * Density Select        [x]  (E/D) ? {user resp.}
     Force Density On (J2-50 DEN - Typ.*
          High Speed):                           [x]  (E/D) ? {user resp.}
     64KB Record Timeout Count:                  [xxx]**
     Blank Tape Timeout Count:                   [xxx]**

          Save new configuration (Y/N) ?
```

* Typical of PERTEC interface.
** See Table 2-4 for typical values.

In order to set the coupler characteristics, the user is prompted for all the information. The user is first prompted for the TSDB/TSBA address. The current setting is displayed along with the "TSDB/TSBA Address" message (user response). A prompt then appears and waits for user reponse. The user response in the above table is indicated by the message "{user response}." The user now has the option of changing the current TSDB/TSBA address. This is done by simply typing a new address at the prompt, followed by a carriage return. If the user does not wish to change the address, simply type a carriage return and the address will remain unchanged. In either case, the user will then be prompted for the dwell time.

The user will again have the same option as before; either change the value or leave it at its current setting. The user will then be prompted for the next piece of information and this process will continue until all the information on the coupler characteristics has been prompted for. The coupler will then prompt the user as to whether or not the new configuration is to be saved in the coupler's NOVRAM.

If the user chooses not to save the new configuration (N), the coupler will simply display a message saying that the new configuration was not saved. Typing a carriage return <CR> at this time will simply display the configuration menu again. If the user chooses to save the new configuration (Y), the coupler will respond with the following:

```
New configuration saved in NOVRAM...
Reboot system to configure coupler hardware!
```

The host system needs to be rebooted only if the TSDB/TSBA address was changed; otherwise, the user need only type a <CR> to return to the configuration menu.

During the prompting of the coupler characteristics, the coupler will respond with an "Invalid Setting" message if the user response is considered invalid.

The coupler expects all user responses to be in octal form.

Table 2-3 lists valid options for each of the coupler configuration characteristics.

Table 2-3. Coupler Configuration Valid Optional Values

The following values are given in octal.

TSDB/TSBA Address: [172520,172524,172530,172534]
(See Table 2-5.)

Dwell Count (Count 270 nsec = Dwell Time): [1-77]

Burst Size: [2-20]

Interrupt Vector: [Any 9-bit address with 2 LSBs being 0]

Interrupt Priority: [4-7]

Extended Features: E or D {for Enable or Disable}

Offline Immediate (Typ. * Disabled): E or D {for Enable or Disable}. Defines either of two commands issued to the tape drive when the Unload command is issued to the coupler, depending upon tape drive interface.

1. Pertec I/O--Disable = Rewind followed by Offline
2. Modified Pertec I/O--Enable = Offline only; tape drives in this category include:
   A. Telex Shamrock
   B.
   C.

Force Read Threshold 2 On (J1-36 RTH2 - Typ.* Long Gap): E or D {for Enable or Disable}
Force Read Threshold 1 On (J1-44 RTH1) - Typ. * Density Select: E or D {for Enable or Disable}
Force Density On (J2-50 DEN - Typ.* High Speed: E or D {for Enable or Disable}

64KB Record Timeout Count: [Any octal byte value: See Table 2-4.]
To calculate: (65536 Bytes/(IPS) x BPI x .157 sec)) +1 = Timeout Count, e.g.--> (65536 Bytes/(25 IPS x 1600 BPI x .157 sec))+1 = 014 ¦ {user response}

Blank Tape Timeout Count: [Any octal byte value: (See Table 2-4.]
To calculate: GCR -> ((15 ft. x 12 in)/(IPS x .157 sec))+1 = Timeout Count. NRZ, PE -> ((25 ft x 12 in)/(IPS x .157 sec))+1 = Timeout Count ¦ {user response}

* Pertec interface

Table 2-4. Pre-Calculated Timeout Counts For Coupler*

TAPE SPEED	BLANK TAPE TIMEOUT COUNT	64 KB RECORD TIMEOUT COUNT
TAPE DENSITY = 1600 BPI		
25 IPS	116	014
50 IPS	050	010
75 IPS	032	005
100 IPS	024	004
125 IPS	020	004
200 IPS	013	004
TAPE DENSITY = 6250 BPI		
25 IPS	056	004
50 IPS	027	004
75 IPS	020	002
100 IPS	014	002
125 IPS	012	002
200 IPS	007	002

* For diagnostic tests of dual/tridensity drives use lowest speed, lowest density values.

How To Find Current TSDB/TSBA Address

In case the user ever changes the coupler address (TSDB/TSBA address) and forgets what value it was set to, the following steps should be taken:

----> FOR LSI-11 SYSTEM

1) Enable the boot address on the coupler and make sure that no other controller is using the same boot address (see details on hardware jumpers). IMPORTANT: Make sure the system is powered down before removing the coupler and changing jumpers!

2) Reinstall the coupler and power up the system. Conduct a boot by typing on the system console either 77775000G or 77773000G, depending on what boot address the user has enabled.

3) Wait for the "*" prompt.

4) Halt the host system processor and look at address location 0. Location 0 should contain the TSDB/TSBA address.

----> FOR MICROVAX SYSTEM

1) Conduct a power-on reset to the coupler (i.e., power down then power back up the host system).

2) Check all possible TSDB/TSBA addresses that can be selected on the coupler via the system console (refer to hex address possibilities in Table 2-5).

How to examine addresses on MicroVAX II:

>>>E/P/W xxxxxxxx <CR> <---- Allows user to examine location xxxxxxxx, a TSDB/TSBA coupler hex address from Table 2-5.

3) Once the user finds an address he suspects is the coupler address, he should deposit a 0 in the corresponding TSSR address. If the coupler responds with a 0480H in the TSDB/TSBA address, then the correct coupler address has been found.

How to deposit a 0 on MicroVAX II:

>>>D/P/W xxxxxxxx 0 <CR> <---- Allows user to deposit a 0 at location xxxxxxxx, a TSSR hex address from Table 2-5.

4) If the coupler address does not respond with 0480H, then go back to step 2 of this procedure.

Table 2-5. IP and SA Hex Address Table To be Entered In Place Of TSDB/TSBA XXXXXXXX For MicroVAX II

TSDB/TSBA REGISTER OCTAL ADDRESS	TSSR REGISTER OCTAL ADDRESS	TSDB/TSBA REGISTER HEX ADDRESS FOR MICROVAX II	TSSR REGISTER HEX ADDRESS FOR MICROVAX II
172520	172522	20001550	20001552
172524	172526	20001554	20001556
172530	172532	20001558	2000155A
172534	172536	2000155C	2000155E

DESCRIPTION OF USER-SELECTABLE COUPLER PARAMETERS

The coupler contains a NOVRAM (non volatile RAM) and one set of jumpers that permit the user to configure a magnetic tape subsystem to meet specific requirements. That configuration parameter which is seldom changed--the bootstrap enable/disable and bootstrap address selection--can be modified by jumpers; more frequently modified parameters can be modified by changing the contents of locations in the NOVRAM. These parameters can be modified without removing the coupler from the system through the use of a "software configuration procedure." This procedure is described in preceding paragraphs. Before reading the following material, users should understand the contents of the Programming Section of this manual (Section 4).

The following paragraphs present a brief description of the pur pose of each parameter. A preceding paragraph of this section, CONFIGURING THE COUPLER, describes how to configure the coupler via a virtual terminal.

The coupler is shipped with all configuration parameters set to a "default" state, which is that configuration most commonly required for an MS device in a Q-bus based system. Those parameters that can be modified and their default settings are as follows:

A. Bootstrap PROM address select/enable or disable: Bootstrap enabled at address 175 000 (jumper selectable).

		DEFAULT VALUE
B.	TSDB/TSBA Address (Software select):	[172520]
C.	Dwell Count (Count x 270 nsec = Dwell Time) (Software select):	[004]
D.	Burst Size (Software select):	[010]
E.	Interrupt Vector (Software select):	[000224]
F.	Interrupt Priority (Software select):	[04]
G.	Extended Features (Software select):	[Disabled]
H.	Offline Immediate (Typ. * Disabled):	[Disabled]
I.	Force Read Threshold 2 On (J1-36 RTH2 - Typ.* Long Gap) (Software select):	[Disabled]
J.	Force Read Threshold 1 On (J1-44 RTH1 - Typ.* Density Select) (Software select):	[Disabled]
K.	Force Density On (J2-50 DEN - Typ.* High Speed) (Software select):	[Disabled]
L.	64KB Record Timeout Count (Software select):	[014]
M.	Blank Tape Timeout Count (Software select):	[116]

* Typ. = Typical of Pertec interface. Other tape drives may have different signal definitions for these lines.

Coupler Address Select

If the system already has one TS11 or TSV05 compatible tape subsystem installed, the base register address of the coupler may have to be changed. When delivered, the default settings stored in NOVRAM are:

```
TSDB/TSBA = 772 520
TSSR      = 772 522
```

These settings are typically recognized by the driver software as logical unit (LU) #0. Note that when the TSDB/TSBA address is selected, the TSSR address is automatically selected Modulus 2 above the TSDB/TSBA address. Suggested optional base register addresses are as follows:

TSDB/TSBA	TSSR
772 524	772 526
772 530	772 532
772 534	772 536

Interrupt Priority Level

The interrupt priority level is set to BR4 (default) when the coupler is shipped. The priority level is software selectable to BR4, BR5, BR6, or BR7.

Even though BR4 is the lowest priority level, the priority level should not need to be changed. The 64K byte buffer on the coupler should prevent "data late" errors.

Interrupt Vector Address Select

The interrupt vector address is set to 224 (LU#0) when the coupler is shipped. The interrupt vector address is software selectable. Note that alternate address 274 in the fixed vector area can be selected if desired. However, if the system already contains an MS device with an interrupt vector assigned in the fixed vector area then addresses in the floating vector area (starting at address 300 octal) must be selected. The address selected will depend upon other devices installed in the system and must follow the rules established by DEC for assigning device addresses in the floating vector space. These rules are contained in most DEC, PDP handbooks, typically in Appendix A. As a matter of reference, the TS11/TSV05 has a rank of 35 in the floating vector area, requires two memory word locations, and must be assigned on a modulus 4 (octal) boundary.

Extended Features Selection

Extended features implies 22-bit addressing and TSV05 compatibility. The TS11 driver may require modifications to support 22-bit addressing on the Q bus.

Block Mode DMA Burst Size and Dwell Time

If block mode DMA is automatically selected, the number of words transferred in each block (burst size) and the dwell time between bursts is software selectable. The default setting for burst size is eight (8) words; the default dwell time setting between block mode transfers is 1.08 microseconds.

Block mode burst sizes are typically four, six, or eight words. The maximum burst size allowed is 16 words by DEC's definition. On older Q-bus based systems with block mode memory capability, the burst size may have to be set to two or four words maximum. Note that the burst size is one word more than the bit settings.

Dwell time is a feature of the DILOG coupler which permits devices at lower priority levels, either logically or physically, on the Q bus to gain access to the processor. With the extensive buffering on the coupler a large amount of data could be stored in the coupler's FIFO buffer ready for transfer to memory. Therefore, as soon as one "burst" of data had been accepted by the memory, the coupler would be ready to request control of the bus almost immediately. If a device, either interrupt driven or DMA, on the same, or lower, priority level was requesting bus control, the coupler could block the processor DMA grant or interrupt acknowledge lines to this device effectively "locking" this device off the bus. Therefore, the coupler contains an adjustable timer which establishes a "dwell" time after a burst transfer and before a subsequent bus request from the coupler to preclude this "lock-out" condition. This dwell time feature can be adjusted for maximum system efficiency. 1 microsecond is usually adequate to permit all devices to gain access to the processor; three microseconds would be a very long dwell time. Note that the dwell time is adjustable between zero, which would be acceptable if the MS device were the only device at level BR4 and the coupler physically farthest removed from the processor in the backplane, and 1.9 milliseconds.

Software Selection of Tape Drive Density (High/Low) or Speed (Start/Stop or Streaming)

Software selection of density (high/low) or mode (start-stop/streaming--also referred to as "low speed/high speed") can be done via: 1) bit 4 in the header word of the command packet (not currently supported by DEC software, 2) bit 5 in the fifth word of a set characteristics data packet (TSV05 only), see Section 4) or 3) a Set Coupler Characteristics command.

Typically, depending upon the tape drive, density selection is done by a switch at the tape drive. This DENSITY SELECT switch usually overrides any remote selection. Refer to the tape drive manual for details. Density selection, both manual and remote, is usually done only at BOT for write-type operations and is then stored in the drive until changed. For read operations, density is automatically selected at BOT by testing the "ID burst." In any case, software density selection can be done ONLY if the tape drive is in the REMOTE DENSITY select mode; applies to dual density, start-stop drives only. Tri-density drives must always have the density selected manually.

Only high/low density or low/high speed can be selected via software driver. However, configuration characteristics commands allow both density and speed selection.

Streaming Drive Long Gap Selection

The operator may select "long gap" mode for PE or GCR streaming drives equipped with this option. The default setting is OFF.

NOTE

DEC always selects the long gap mode for their TU80 streaming tape subsystem. This 1600 cpi PE streamer operates at 100 ips in the high speed mode. The long gap mode can reduce the amount of data written on tape, depending on record size, software instruction times, tape drive Long Gap option type (fixed gap, variable gap), etc. Tapes with either normal or long gaps can be read regardless of the setting of Bit 12.

The long gap mode should be selected when using any DEC disk backup software with a streaming tape drive. Selecting long gap mode does not mean that all inter-record gaps (IRG) written on tape will be long; for variable gap mode only, the gap length is primarily a function of software instruction times. Tapes with either normal or long gaps can be read regardless of software selection. Note that start-stop or cached tape drives do not have this option, thus the software selection is ignored.

The long gap mode merely extends the "reinstruct time" window of the streamer after the end of each record. This delays triggering the repositioning cycle longer than normal. Note that if the software does not provide sequential write instructions within the streamer reinstruct time, the streamer will enter a repositioning cycle which can take over one second. Table 2-6 compares normal and long gap reinstruct times for various models of PE and GCR tape drives.

Table 2-6. Normal/Long Gap Reinstruct Time Comparisons

DRIVE	SPEED IPS IDEN 011	FORMAT	PE REINSTRUCT (ms) NORMAL GAP WR	PE REINSTRUCT (ms) NORMAL GAP RD	PE REINSTRUCT (ms) LONG GAP WR	PE REINSTRUCT (ms) LONG GAP RD	GCR REINSTRUCT (ms) NORMAL GAP WR	GCR REINSTRUCT (ms) NORMAL GAP RD	GCR REINSTRUCT (ms) LONG GAP WR	GCR REINSTRUCT (ms) LONG GAP RD	LONG GAP SELECT
Cipher F880	100	PE	2.0-3.5	3.0-4.0	4.0-7.0	6.0-8.0					Switch 2-3 ON
CDC 92181	100	PE	3.5	12	9.5	12					
CDC 92185 (Keystone)	75	PE/GCR	5.5	15.5	13.5	15.5	1.5	3	5.5	7.5	
DEC TU80	100	PE			9.5	12					
FUJ M2442A	100	PE/GCR	4	5.5	10	11.5	1	2.5	4	5.5	Mode A
STC 2922	100	PE/GCR	3.5	5	9.5	11	0.5	2	6.5	8	
Kennedy 9600	50/100	PE/2XPE/ NRZI	3.5	3.5	9.5	3.5					J1-36[1]
Pertec FS1000	25/100										J1-44

NOTE

1. PE = 1600 bpi; 2XPE = 3200 bpi, GCR = 6250 bpi.
2. J1-36 = 0 volts (high) = Long Gap Select.

If sequential software write commands occur within the normal reinstruct time window, a normal IRG will be erased. If sequential software write commands occur after the normal reinstruct time, but before the end of the long gap window, a longer IRG will be written but the drive will not enter the reposition cycle. If a sequential write command does not occur until after the long gap window time out, the repositioning cycle time penalty is invoked before a new write command can be accepted.

Therefore, the long gap mode is appropriate for two cases:

A. When streaming disk backup software usually generates the next write instruction within the normal reinstruct time window, but occasionally is delayed due to missing a disk rotation (seek command). This results in negligible loss of tape capacity because only a small percentage of tape records are followed by a longer than normal IRG.

B. When minimum time to perform a disk backup is more important than tape capacity, and the software usually cannot meet the normal reinstruct time window requirements, but does fall within the long gap reinstruct time requirements. Even though longer than normal gaps are erased between records (reducing tape capacity), a high-speed streaming mode will be maintained to guarantee disk backup. If large record sizes are written to tape, the ratio of record size to blank tape will be such that good tape capacity may still be realized.

There is a major difference in reinstruct time between GCR and PE streaming tape drives even when operated at the same tape speed (see Table 2-6). This is because of the difference in the IRG size between the two formats: PE IRG size is 0.6 inch; GCR IRG size is 0.3 inch. Typical reinstruct times (normal gap) for 100 ips streamers in the write mode are 3.5 milliseconds in PE and 0.5 to 1.0 millisecond in GCR. Read mode reinstruct times are slightly longer because the physical distance between the write/read heads does not have to be subtracted from the gap spacing as is required for write mode calculations. This is because read-after-write parity checking is required in the write mode.

Since all DEC streaming software is designed for the TU80 (PE streaming tape drive), which always has long gap mode selected, the long gap mode is recommended for both PE and GCR streamers when using DEC software. To re-emphasize, streaming performance is dependent upon software response time between records--not hardware response time.

64K Byte Record And Blank Tape Timeout Count

The purpose of these two parameters is the same; to prevent the condition termed "Tape Runaway." Tape Runaway is when--for no apparent reason--the tape runs off the end of the reel.

Establishing coupler characteristics sets two timers within the coupler. The timer value associated with 64KB record timeout count is invoked during read/write commands. The timer value associated with blank tape timeout count is invoked during blank tape commands (IRG, EOF, etc.)

If during the associated commands, the timer values are equalled or exceeded, the coupler institutes "stop tape" commands to prevent the tape from running off the tape reels.

Formulas for establishing the timer values depending on tape speed are given in the "Configuring The Coupler" paragraph of this section. Table 2-4 gives typical values.

Offline Immediate Characteristic

Although most tape drive interfaces conform to the "Pertec I/O" interface standard, newer drives with enhanced features occasionally differ in line definitions and the effect of commands issued to the coupler. One of these cases involves the result of the "Unload" command. When this command is issued to the coupler:

A. Pertec I/O compatible drives perform a Rewind followed by an Offline state.

B. Modified Pertec I/O drives, such as the Telex Shamrock, enter an Offline state only.

The Offline Immediate characteristic accommodates either of these conditions.

SECTION 3

OPERATION

INTRODUCTION

Prior to operating the system, the tape drive manual sections describing the controls and indicators on the tape drive and procedures for mounting and removing tape reels should be read. To prevent loss of data or damage to the magnetic tape, the following precautions should be observed:

a. Always handle a tape reel by the hub hole. Squeezing the reel flanges can cause damage to the tape edges when winding or unwinding tape.

b. Never touch the portion of tape between the BOT and EOT markers. Oils from fingers attract dust and dirt. Do not allow the end of the tape to drag on the floor.

c. Never use a contaminated reel of tape. This spreads dirt to clean tape reels and can affect tape drive operation.

d. Always store tape reels inside their containers. Keep empty containers closed so dust and dirt cannot get inside.

e. Inspect tapes, reels, and containers for dust and dirt. Replace take-up reels that are old or damaged.

f. Do not smoke near the tape drive or tape storage area. Tobacco smoke and ash are especially damaging to tape.

g. Do not place the tape drive near a line printer or other device that produces paper dust.

h. Clean the tape path frequently.

Note that tape drives permit offline or online operation. The offline mode is controlled by switches on the tape drive. The online mode is controlled by programmed commands from the computer via the coupler and formatter. When system operation is desired, be sure the tape drive ONLINE indicator is lit. Online operation is a function of program commands described in Section 4 of this manual.

Tape Format

For detailed information on tape format characteristics see formatter and tape drive manuals.

Booting From Magnetic Tapes

1. Place the tape transport "ONLINE" and position the tape at "Beginning of Tape."

2. If the CPU is equipped with a TS11 hardware bootstrap, or the bootstrap PROM on the coupler is enabled, simply type "MS0" <CR> (RETURN key). If no hardware bootstrap is installed, boot as shown in Table 3-1 or Table 3-2. Table 3-1 is an abbreviated bootstrap routine.

Table 3-1. TSV05 Short Bootstrap Routine

ADDRESS	DATA	CODE
001000	12701, 172522	;MOV #TSSR,R1
001004	12703, 17252	;MOV #TSDB,R3
001010	12704, 001046	;MOV #NUM+20,R4
001014	105711, 100376	;TSTB (R1)
		BPL.-2
001020	112737, 00200, 172523	;MOVB 200,172523
001026	012713, 002064	;MOV #PKT1,(R3)
001032	105711, 100376	;TSTB (R1)
		BPL.-2
001036	5000	;CLR R0
001040	5007	;CLR PC
001042	46523	;NUM=MS(ASCII)

DIAGNOSTICS

Online and offline diagnostics and switch settings for the tape drive are described in the tape drive manual. The board-edge, red diagnostic LED is used either to indicate command activity or to flash an error code.

During TS11/TSV05 command processing, the LED will be ON while a command is active and OFF when a command is complete.

During self-test diagnostics, the LED will be ON for about seven seconds, then OFF for about seven seconds during each pass of the diagnostics. If an error occurs during diagnostics, a 5-bit error code is flashed (Morse-code like)--most significant bit first; a long flash = logic 1, a short flash = logic 0. For example, short, short, short, long, short = 00010 binary (02 hexadecimal).

The error codes conform to MSCP defined codes (see Table 3-3). If an error occurs, the TSSR register will indicate an error occurred. The TSBA register will be loaded with a modified MSCP error definition (Bit 15 = error = 1, step 1-4 = 0 and error code), and the LED will flash the error code. The TSBA register is loaded with 125 125 or 52 652 during diagnostics.

The DEC software diagnostics and "exerciser" programs that can be run with the coupler depend upon the computer and software operating system being used.

NOTE

Some of the functional tests report invalid errors when cached tape drives are used with the coupler. These errors occur in sub-tests that involve specific time delay measurements and simulate detection of blank tape. For example, after erasing a long gap on tape, an OPI error is expected when the tape is re-read. The OPI error will not be generated when testing a cached tape subsystem. The known errors caused by cached tape subsystems are noted where appropriate in the following text.

Table 3-2. TS11/TU80/TSV05 Bootstrap Routine

Address	Data					Code
			TSBA	=	172520	TS11 ADDRESS REGISTER ADDRESS
			TSSR	=	172522	TS11 STATUS REGISTER ADDRESS
001000	012700	172520	START:	MOV	#TSBA, R0	GET ADDRESS OF TSBA INTO R0
001004	012701	172522		MOV	#TSSR, R1	GET ADDRESS OF TSSR INTO R1
001010	005011			CLR	(R1)	INIT AND REWIND TAPE
001012	105711			TSTB	(R1)	TEST IF 'SSR' IS SET
001014	100376			BPL	. – 2	AND WAIT UNTIL IT IS
001016	012710	001064'		MOV	#PKT1, (R0)	ISSUE SET-CHARACTERISTICS COMMAND
001022	105711			TSTB	(R1)	TEST IF 'SSR' IS SET
001024	100376			BPL	. – 2	AND WAIT UNTIL IT IS
001026	012710	001104'		MOV	#PKT2, (R0)	ISSUE READ OF FIRST RECORD ('MM:' BOOT)
001032	105711			TSTB	(R1)	TEST IF 'SSR' IS SET
001034	100376			BPL	. – 2	AND WAIT UNTIL IT IS
001036	012710	001104'		MOV	#PKT2, (R0)	SKIP OF SECOND RECORD (HEADER FILE)
001042	105711			TSTB	(R1)	TEST IF 'SSR' IS SET
001044	100376			BPL	. – 2	AND WAIT UNTIL IT IS
001046	005711			TST	(R1)	ANY ERRORS ? ? ? ?
001050	100421			BMI	HLT	HALT IN FRONT OF MESSAGE IF ERRORS
001052	012704	001102'		MOV	#NUM + 20.R4	ADDRESS OF 'NUM' ·R4
001056	005000			CLR	R0	0 ·R0 (UNIT #0)
001060	005007			CLR	PC	RESUME EXECUTION AT ZERO IF NO ERRORS
						046523 (OCTAL) = MS (ASCII)
001062	046523		NUM:	046523		
						SET-CHARACTERISTICS PACKET
001064	140004		PKT1:	140004		
001066	001074'			PK		
001070	000000			0		
001072	000010			8.		
001074	001116'		PK:	MES		
001076	000000			0		
001100	000016			14.		
001102	000000			0		
						READ-DATA PACKET
001104	140001		PKT2:	140001		
001106	000000			0		
001110	000000			0		
001112	001000			512.		
001114	000000		HLT:	HALT		
001116			MES:			

Table 3-3. Error Code Definitions

HEX	OCTAL	DECIMAL	DEFINITION
0001	1	001:BYTE	;Envelope/Packet Read (parity or timeout) ; [QBUS Command Packet Read]
0002	2	002:BYTE	;Envelope/Packet Write (parity or timeout) ; [QBUS Command Packet Write]
0003	3	003:BYTE	;Controller ROM and RAM parity
0004	4	004:BYTE	;Controller RAM parity. [Data after RAM]
0005	5	005:BYTE	;Controller ROM parity. [NOVRAM Checksum]
0006	6	006:BYTE	;Ring Read (parity or timeout) ; [QBUS Command/Response Ring Read]
0007	7	007:BYTE	;Ring Write (parity or timeout) ; [QBUS Command/Response Ring Write]
0008	10	008:BYTE	;Interrupt Master [QBUS Interrupt]
0009	11	009:BYTE	;Host Access Timeout [MSCP]
000A	12	010:BYTE	;Credit Limit Exceeded [MSCP]
000B	13	011:BYTE	;Unibus Master Error [QBUS DMA ?]
000C	14	012:BYTE	;Diagnostic Controller Fatal Error ; [CPU Failure]
000D	15	013:BYTE	;Instruction Loop Timeout ; [Watchdog Timer]
000E	16	014:BYTE	;Invalid Connection Identifier [MSCP]
000F	17	015:BYTE	;Interrupt Write [?]
0010	20	016:BYTE	;MAINTENANCE READ/WRITE Invalid Region ; Identifier [MSCP]
0011	21	017:BYTE	;MAINTENANCE WRITE Load to Non-Loadable ; Controller [MSCP]
0012	22	018:BYTE	;Controller RAM Error (non-parity) ; [Static RAM]
0013	23	019:BYTE	;INIT Sequence Error [MSCP Initialization]
0014	24	020:BYTE	;High-Level Protocol Incompatibility Error ; [MSCP]
0015	25	021:BYTE	;Purge/Poll Hardware Failure ; [MSCP Initialization Diagnostic Failure]
0016	26	022:BYTE	;NOVRAM Checksum Failure
0017	27	023:BYTE	;PERTEC Error
0018	30	024:BYTE	;DMA Controller Error
0019	31	025:BYTE	;QBIC Error QBUS IC
001A	32	026:BYTE	;QBUS DMA Error
001B	33	027:BYTE	;QBUS Power Failure [Unions ACLO Active ; on QBUS-BPOK Inactive

Operating System Software Diagnostics

Most DEC operating system software packages include some form of concurrent DMA I/O exerciser tests. In some cases these tests can be run even while the operating system is online--as long as the peripherals to be tested are either not in use or, like disks, can have a reserved area assigned.

These exercisers are typically called UETP (User Environment Test Packages), IOX (Input/Output Exerciser), or MTEXER (Magnetic Tape Exerciser).

The best way to run these exerciser tests is to activate testing on more than one DMA device simultaneously (such as disk and magnetic tape). In this way concurrent DMA operations are also tested.

The operating system exerciser programs that can be run with the coupler are as follows:

A. MicroVMS: UETP

B. RSX11M/M+: IOX

C. RSTS: MTEXER

Typically, these are the only programs that need be run after installation to verify proper subsystem operation.

Functional and Data Reliability Diagnostics

This class of diagnostics should be run when a subsystem failure is suspected. The diagnostics are run under an appropriate diagnostic operating system, such as XXDP+ for PDP-11 type systems.

PDP-11 Diagnostics

The tests that can be run under XXDP+ for Q-bus based PDP-11 systems are as follows:

A. CZTUWAD - TU80 Functional Tests 1 through 11: All tests should run error free except Tests 2 and 10. During 2 and 10, the diagnostic does not wait for the SSR bit to be set in the TSSR register on a coupler buffer test due to a TSSR TSBA read delay.

B. CZTUXA0 - TU80 Functional Tests 1 through 8: All tests except test 4 should run error free with the following patches:

   1. Address = 046 270: was = 104456, patch to = 137
   2. Address = 046 272: was = 1057, patch to = 46316

CZTUXA0 Diagnostic test 4 verifies that the coupler returns Non Existent Memory (NXM) status for DMA memory transfer attempts into the upper 8K byte I/O page.

Two invalid error messages occur if during DMA transfers computer memory increments across the upper 8K byte I/O page memory boundary or the coupler subsystem contains a cache tape that has a limit on the maximum record size.

The first error typically occurs when more than 248K bytes of memory is installed. If the following error occurs, check the memory configuration options:

1. Error 418, test 4, subtest 4, PC 037254 Error Message, "TSSR not correct after WRITE command reject due to NXM."

The second error is due to the cache tape drive's limitation on maximum record size. The cache tape can be internally configured to define the maximum record size. Typical configurations are between 16K and 24K bytes. The diagnostic causes the coupler to advance through DMA memory addresses until either addresses past installed memory are issued or addresses are issued into the I/O page. This should cause NXM status to be reported by the coupler. The diagnostic does this by writing several large records (approximately 62K bytes), which causes the coupler to advance through computer memory until available memory is exceeded and NXM is generated. Unfortunately, the cache tape goes into a "drive fault" mode if the configured maximum record size is exceeded. This results in the following error:

1. Error 421, test 4, subtest 5, PC 037520 Error Message, "TSSR not correct after WRITE to nonexistent memory."

2. Address = 37412; was = 0, patch to = 1

C. CZTUYA0 - TU80 Functional Tests 1 through 4: All tests except test 3 should run error free with the following patches:

1. Address = 062 344: was = 13737, patch to = 12737
2. Address = 061 752: was = 13737, patch to = 12737

Test 3, subtest 5 reports invalid error 355 at PC 055434 if cache tape is used with the coupler. The error message is, "write data retries erase tape not long enough."

D. CZTUZA0 - TU80 Functional Tests 1 through 6: All tests except tests 4 and 5 should run error free.

Test 4, subtest 3 reports invalid errors 427/428 at PC 050772, 051026, 050772 if cache tape is used with the coupler. The error messages are as follows:

1. Erase failed to clear (ERASE) tape properly.
2. OPI bit (XST3) failed to set.

Test 5, subtest 1 reports invalid errors 517/526 at PC 054200, 055014 if cache tape is used with the coupler. The error message is, "unable to clear EOT indication, bit 0 (XST0)."

E. CZTUVB0 - TU80 Data Reliability Tests 1 through 5 (requires 2400 feet of tape): All tests except test 3 (streaming) should run error free.

F. CZTSHC0 - TS11 Data Reliability

G. CXTSAA0 - TS11 DEC/X11 System Exerciser

MicroVAX Diagnostics

The tests that can be run under the MicroVAX EVM Diagnostics are as follows:

A. EVMAA - TS11 Data Reliability Tests 1 through 4: See Table 3-4 and EVM Error Notes.

B. EVMBD - TU80 Functional Tests 1 through 16: See Table 3-4.

C. EVMBE - TU80 Functional Tests 1 through 12: See Table 3-4 and EVM Error Notes.

Table 3-4. MicroVAX EVM Diagnostic Error Reference

DIAG. REV.	TEST	TU80	START/STOP	STREAMER	CACHE
EVMBD 1.0	1-16	OK	OK	OK	OK
EVMBE 1.1	1-4	OK	OK	OK	OK
EVMBE 1.1	5	OK	OK	ERR 1	ERR 1
EVMBE 1.1	6-9	OK	OK	OK	OK
EVMBE 1.1	10	OK	OK	OK	ERR 2
EVMBE 1.1	11	OK	OK	OK	ERR 3
EVMBE 1.1	12	OK	ERR 4	ERR 4	ERR 4
EVMAA 12.1	1	OK	OK	OK	OK
EVMAA 12.1	2	ERR 5	ERR 5	ERR 5	ERR 5
EVMAA 12.1	3-4	OK	OK	OK	OK

Note: Refer to EVM Error Notes paragraph for explanations and patches where applicable.

MicroVAX EVM Diagnostics Error Notes

ERR 1 : Write Data Retry Test

********EVMBE TU80 FUNCTIONAL LEVEL - 1.1 ********
Pass 1. test 5. subtest 5. error 20 XX-XXX-XXXX XX:XX:XX.XX
Testing MSAO: The Erase gap ON WRITE RETRY is not long enough

Summary: This test does a timing analysis between the WRITE COMMAND and the WRITE RETRY COMMAND. Tape drives that have long reposition times will fail this test.

ERR 2 : ERASE AND OPERATION INCOMPLETE TEST

********EVMBE TU80 FUNCTIONAL LEVEL - 1.1 ********
Pass 1. test 10. subtest 2. error 7. XX-XXX-XXXX XX:XX:XX:XX
Testing MSAO: ERASE Failed to Clear (Erase) Tape Properly

Summary: This test will ERASE the tape to EOT and issue REVERSE COMMANDS and FORWARD COMMANDS to check for OPI errors. Tape drives that do not move tape and stop after the MAXIMUM RECORD GAP length during READ REVERSE COMMANDS will fail this test.

ERR 3 : Operations at EOT Test

********EVMBE TU80 FUNCTIONAL LEVEL - 1.1********
Pass 1. test 11. subtest 1. error 16. XX-XXX-XXXX XX:XX:XX:XX
Testing MSAO: TSSR Incorrect After Position (SPACE RECORDS) Command

Summary: This test will do operations to move tape before and after EOT and check that EOT is reported correctly. Most CACHE tape drives cannot accurately report EOT due to the fact that the records in the CACHE may not reflect the true position on the tape.

ERR 4 : Function Timing Test

********EVMBE TU80 FUNCTIONAL LEVEL - 1.1 ********
Pass 1. test 12. subtest 0. error 12. XX-XXX-XXXX XX:XX:XX:XX
Testing MSAO: Drive Failed to Switch to High Speed Mode on SPA

Summary: This test will verify that a TU80 is capable of switching from LOW SPEED to HIGH SPEED automatically. All NON-TU80 drives will fail this test unless it has auto speed switching capability. A patch can be made to the diagnostic to remedy this error for START-STOP and STREAMING tape drives.

Patch Procedure : VMS 3.5

```
$ PATCH/ABS EVMBE.EXE <CR>

PATCH>d/word 0ef15 <CR>
NEW>4e <CR>
NEW>exit <CR>
OLD:    0000EF15:   008F
NEW:    0000EF15:   004E
PATCH>update <CR>
PATCH>  ^Z

$
```

ERR 5 : Tape Qualification Test

```
**EVMAA TE16.TS11.TU45.TU77.TU78.TU80 DATA RELIABILITY DIAG - 12.1 **
 Pass 1. test 2. subtest 0. err 1. XX-XXX-XXXX XX:XX:XX:XX
 Testing MSAO:  COULD NOT ISSUE A READ SWAP FUNCTION
```

Summary: This error is due to a software bug. The diagnostic tries to send a COMMAND QUEUE PACKET to the driver with IO$M_SWAP set in the command word. The IO$M_SWAP bit was mis-defined as BIT 10. The IO$M_SWAP bit should have been defined as BIT 8. A patch can be made to remedy this problem.

Patch Procedure : VMS 3.5

```
$ PATCH/ABS EVMAA.EXE <CR>

PATCH>d 2cd8 <CR>
NEW>10c <CR>
NEW>exit <CR>
OLD:    00002CD8:    0000040C
NEW:    00002CD8:    0000010C
PATCH>d 2d04 <CR>
NEW>10b <CR>
NEW>exit <CR>
OLD:    00002D04     0000040B
NEW:    00002D04     0000010B
PATCH>d 2d54 <CR>
NEW10c <CR>
NEW>exit <CR>
OLD:    00002D54     0000040C
NEW:    00002D54     0000010C
PATCH>update <CR>
PATCH> ^Z

$
```

SECTION 4
PROGRAMMING

PROGRAMMING DEFINITIONS

FUNCTION: The expected activity of the tape system (read, write, rewind).

COMMAND: The instruction which initiates a function.

INSTRUCTION: One or more orders executed in a prescribed sequence that cause a function to be performed.

ADDRESS: The binary code placed on the A00L-A17L lines by the bus master to select a register in a slave device. Note that "register" can be either discrete elements (flip-flops) or memory elements (core, solid state RAM or ROM). When addressing devices other than computer internal memory, i.e., peripheral device registers, the upper 4K words address space is used.

REGISTER: An associated group of memory elements that react to a single address and store information (status, control, data) for use by other assemblies of the total computer system.

PROGRAM SEQUENCES

Commands, data, and status are sent between the coupler and the processor (CPU) in groups of bytes called "packets." There are four types of packets:

1. Command packet
2. Data packet
3. Characteristics packet
4. Message packet (also called end packet). A summary is shown at the end of this section.

The packets are established in main memory by the CPU. Typically there are two main memory packet (buffer) areas: Data buffers and control/status buffers. Both areas can be controlled by either the CPU or the coupler. The buffer contents and sources are as follows:

Data Buffer	Packet Buffer	Size	Source
	command	8 bytes	CPU
data from tape		1 byte to 65 Kbytes	Coupler
data to tape		1 byte to 65 Kbytes	CPU
	set characteristics	6-10 bytes	CPU
	message	14-16 bytes	Coupler

This packet technique for communicating between the CPU and the coupler improves computer system efficiency by reducing the number of information transfers to and from the tape system under processor control; in addition to data transfers, status and command information is transferred via the DMA facility.

The coupler has two program-accessible registers: the status register (TSSR) and the combination data buffer/bus address register (TSDB/TSBA). Additional status reflecting the state of the tape subsystem is stored in the message packet buffer located in main memory.

A typical read or write command sequence is as follows:

1. CPU reads status register (TSSR).
2. CPU loads (writes) data buffer register (TSDB) with starting address of a command packet, which is then shifted and loaded into the internal TSBA register of the coupler.
3. The controller accesses the command packet, which is typically "set characteristics." Note that the set characteristics command packet comprises 3 to 5 successive memory locations (6-10 bytes) that contain (see Figure 4-1):
   A. Command header word
   B. Least significant bits of characteristic packet address
   C. Most significant bits of characteristic packet address
   D. Byte count of characteristics packet

   The contents of the set characteristics packet are now accessed by the coupler. The principle purpose of executing this command is to get the starting address of the end message packet. Upon conclusion of a read or write operation, the message packet locations are loaded with status words by the coupler.
4. CPU loads Data Buffer Register (TSDB) with starting address of the next command packet, which is then shifted and loaded into the TSBA register of the coupler.

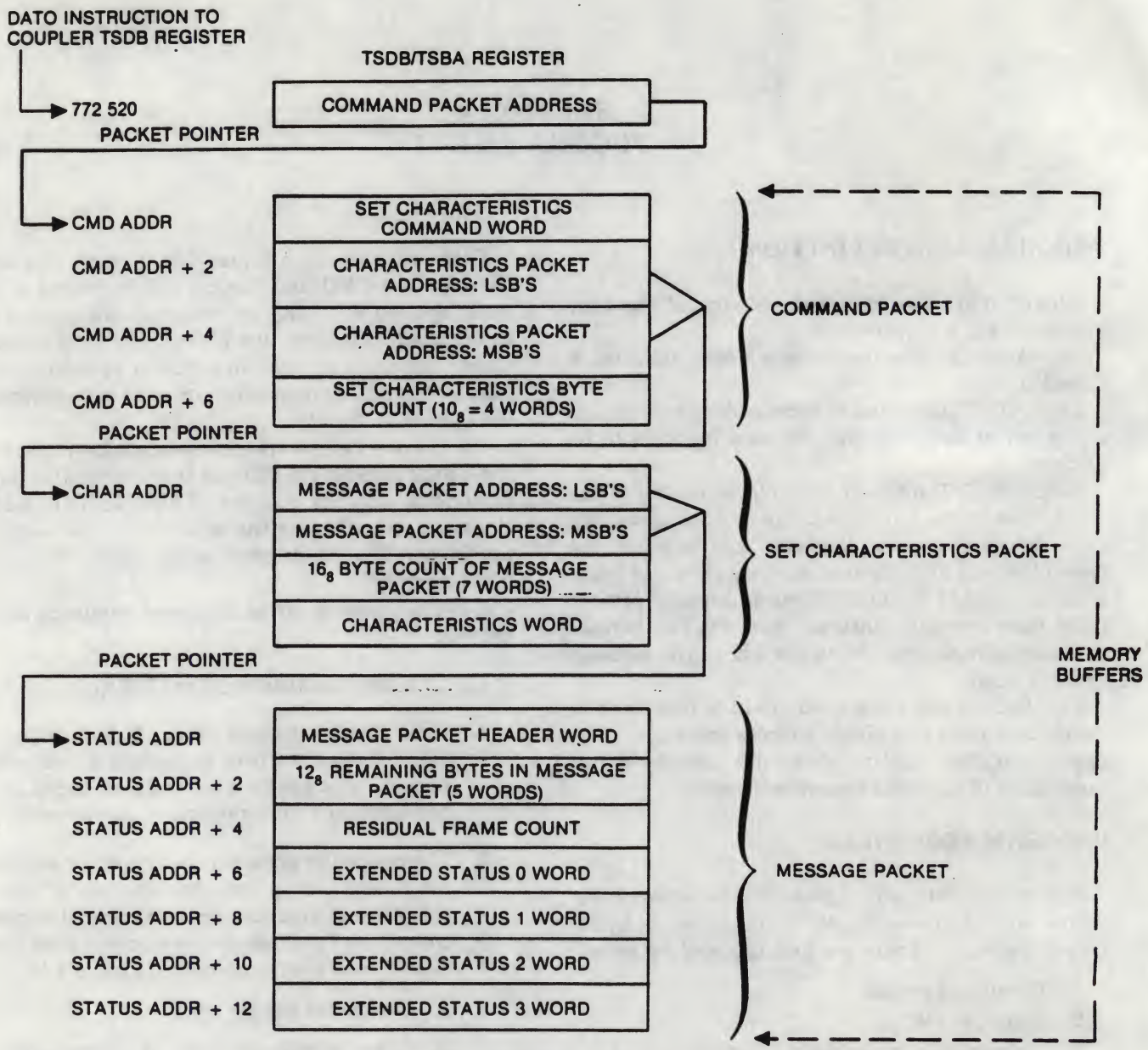


Figure 4-1. Typical SET CHARACTERISTICS Command Sequence

5. The coupler TSBA contents access the next command packet. Read/write command packets comprise four successive memory locations (eight bytes) that contain (see Figure 4-2):
   A. Command header word.
   B. Least significant bits of starting location in memory, where data is to be read from (write command) or written to (read command).
   C. Most significant byte of starting memory location.
   D. Number of bytes to be transferred (byte count).
6. The coupler as bus master now begins the transfer of data between main memory and the selected tape drive.
7. Reading or writing of data continues until either the proper byte count is reached or until the end of a record (reading) is detected.
8. Status information is now loaded into:
   A. Register TSSR in the coupler
   B. The message packet as defined by the last set characteristics command.
9. If instructed, the coupler generates an interrupt to signal the end of a command.

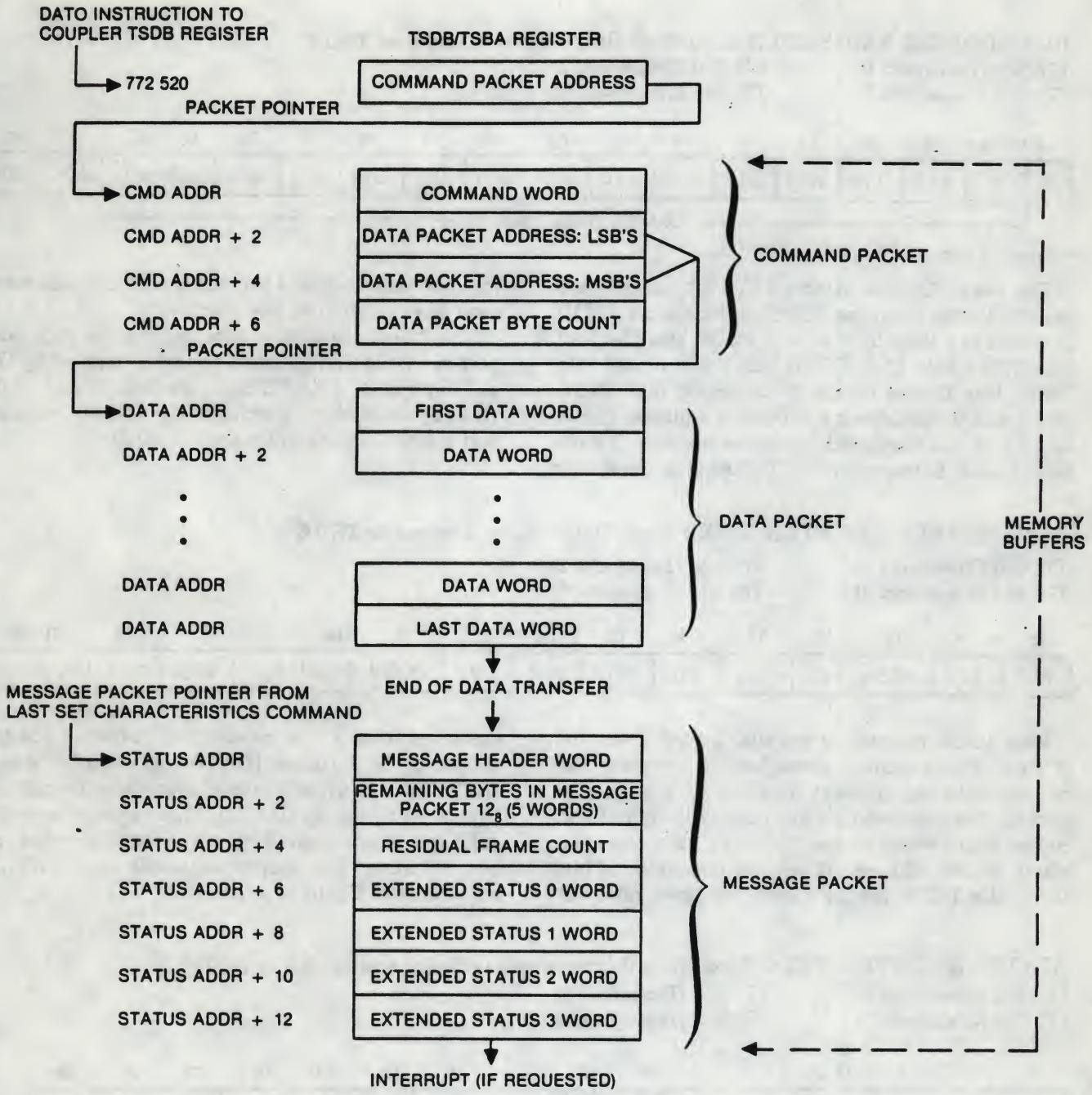


Figure 4-2. READ/WRITE Command Sequence

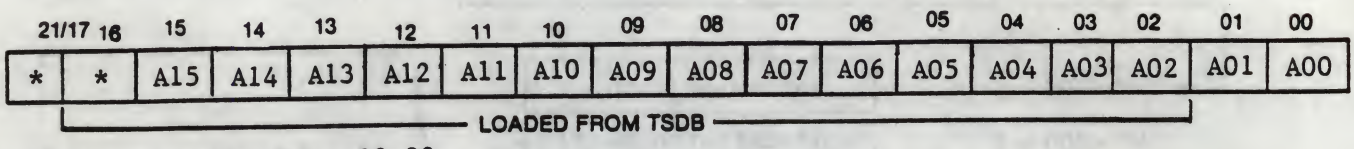
A "set characteristics" command packet was mentioned in step 3 of the read/write command sequence. The purpose of this command is to load the starting address of the message packet into the coupler, and to load a characteristics word into the coupler. The characteristics word defines certain options that are available to the software.

REGISTERS AND PACKETS

The following material describes the coupler registers and illustrates and describes the contents of the packets.

BUS ADDRESS REGISTER (TSBA) Read Only—Same Address as TSDB

772 520 (Transport 0) **772 530 (Transport 2)**
772 524 (Transport 1) **772 534 (Transport 3)**



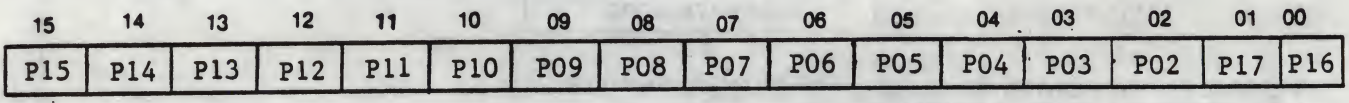
* Read from TSSR, bits 08-09.

The lower 18 bits of this 18/22-bit register are parallel loaded from the TSDB each time the TSDB is loaded as a slave by the CPU. TSDB bits 15-2 load into TSBA bits 15-2; TSDB bits 1 and 0 load into TSBA bits 17 and 16. Zeros are loaded into TSBA bits 1 and 0, specifying a Modulo-4 address. TSBA bits 17-16 are displayed in status register (TSSR) bits 9 and 8 respectively. TSBA is a read-only register that contains the address of the last word read from or written into memory.

The 22-bit version of this register is only supported by the TSV05 handler, and is enabled by the EXTENDED FEATURES switch. TSBA bits 18-21 are loaded via a write to the TSDBX register and are not displayed (cannot be read).

DATA BUFFER REGISTER (TSDB) Write Only—Same Address as TSBA

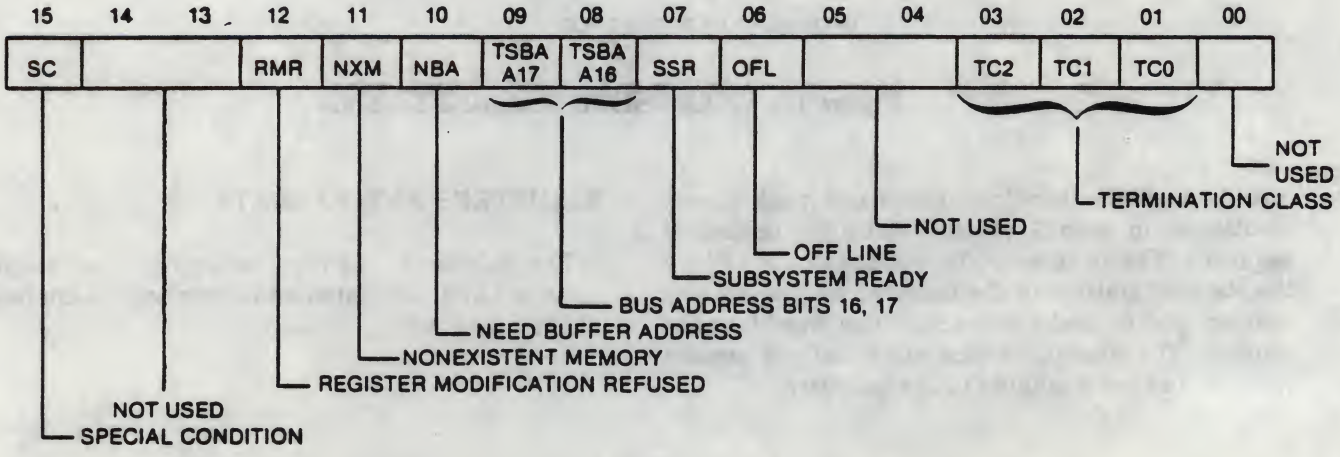
772 520 (Transport 0) **772 530 (Transport 2)**
772 524 (Transport 1) **772 534 (Transport 3)**



This 16-bit register is parallel loaded from the Q Bus. This register, when loaded, provides the coupler with the memory location of a command packet. The command packet pointer is shifted and copied into 16-bits of the TSBA to form the command packet address. When the controller is bus slave, the TSDB can be loaded by three different transfers from a bus master; two transfers are for maintenance purposes (DAT0B to high byte and DAT0B to low byte); the third transfer is for normal command initiation (DAT0). This register is write-only and is not cleared by subsystem initialize, or bus initialize. The coupler responds with BRPLY any time the TSDB is written.

STATUS REGISTER (TSSR) Read/Write (Write causes initialize and rewind to BOT)

772 522 (Transport 0) **772 532 (Transport 2)**
772 526 (Transport 1) **772 536 (Transport 3)**



In addition to this register, the coupler provides additional information in the Message Packets that it loads into main memory at the termination of each command.

Status Register Bit Definitions

Bit	Name	Termination Class (TC) Octal Code	Definition
00	—	—	Not Used.
01	TC0	—	Termination Class Bit 00: See TC2 (bit 03) below.
02	TC1	—	Termination Class Bit 01: See TC2 (bit 03) below.
03	TC2	—	Termination Class Bit 02: This bit, along with the TC1 and TC0 bits, acts as an offset value when an error or exception condition occurs on a command. Each of the eight possible values of this field represents a particular class of errors or exceptions. The code provided in this field is expected to be utilized as an offset into a dispatch table for handling the condition. These bits are useful only when special condition (SC) bit 15 is set. See Table 4-1.
06	OFL	—	Off-Line: When set, this bit indicates that the transport is off-line and unavailable for any tape motion commands.
07	SSR	—	Subsystem Ready: When set, this bit indicates that the subsystem is not busy and is ready to accept a new command pointer.
08	A16	—	Bus Address Bit 16: See A17 below (bit 09).
09	A17	—	Bus Address Bit 17: A17 and A16 (bits 08 and 09) display the values of bits 17 and 16 in the TSBA register.
10	NBA	—	Need Buffer Address: When set, this bit indicates that the transport needs a message buffer address. This bit is cleared after successful completion of a Set Characteristics command; it is always set after subsystem initialization.
11	NXM	4/5	Nonexistent Memory: This bit is set by the controller when trying to transfer to or from a memory location which does not exist. It may occur when fetching the command packet, fetching or storing data, or storing the message packet.
12	RMR	—	Register Modifications Refused: This bit is set by the controller when a command pointer is loaded into TSDB and Subsystem Ready (SSR) is not set. This bit may set a bug-free system if ATTN interrupts are enabled.
13	—	—	Not Used.
14	—	—	Not Used.
15	SC	—	Special Conditions: When set, this bit indicates that the last command was not completed without incident. Specifically, either an error was detected or an exception condition occurred. An exception condition could be a tape mark on read commands, reverse motion at BOT, EOT while writing, etc.

Table 4-1. Status Register Termination Class Codes

TSSR Bits 3, 2, 1	Description
000	Normal termination.
001	Attention Condition: Set by change in offline (bit 06) or a microdiagnostic failure defined by Extended Status 3 word.
010	Tape Status Alert: Set by tape mark, short records, long records, or EOT bits in Extended Status 0 word.
011	Function Reject: Set by off line, write lock error, illegal command, illegal address, on-line status change, or BOT in Extended Status 0 word.
100	Recoverable error (tape position—one record down from start of function)
101	Recoverable error (tape not moved)
110	Unrecoverable error (tape position lost)

EXTENDED DATA BUFFER REGISTER (TSDBX)—TSV05 Only

772 523 (Transport 0)
772 527 (Transport 1)
772 533 (Transport 2)
772 537 (Transport 3)

LSI-11 Bus Bits:	15	14	13	12	11	10	09	08
High Byte Data Bits:	07	06	05	04	03	02	01	00
	BT	0	0	0	A21	A20	A19	A18

TSDBX is supported only by the TSV05 handler and is a write-only hardware byte register located at the fourth byte address of the I/O register block; this address corresponds to the high-order byte of the TSSR register. The TSDBX is used to specify the most significant four bits of a 22-bit command pointer address and to allow an automatic tape boot sequence to be performed.

TSDBX can be written only by a byte-access (DATOB) cycle addressed to the high byte of TSSR. If the EXTENDED FEATURES switch is OFF when the TSDBX is written, only the Boot bit (07) is examined; the other bits are ignored.

If the EXTENDED FEATURES switch is ON when TSDBX is written, the contents of the least significant four bits of TSDBX are transferred to bits 18 through 21 of the internal TSBA (bus address) register for use as a command pointer. The low order 18 bits of the command pointer are specified by writing into the TSDB register, which starts an operation and then clears TSDBX. Therefore, a subsequent load of only the TSDB will specify a 22-bit command pointer address with the high-order four bits equal to zero.

For the TSDBX register to be properly written, the SSR (Subsystem Ready) bit in TSSR must be set; if it is not, the RMR (Register Modification Refused) bit will be set and no modification to TSDBX will occur. When the TSDBX is written, the SSR bit is not cleared. Therefore, RMR should be checked, before TSDB is written. Writing the TSDB will begin processing on TSDBX. If the Boot bit is *not* set, the command pointed to by the 22-bit TSDB will be retrieved and command processing will begin. If the Boot bit is set, SSR will remain clear until the boot sequence is complete or until an error occurs.

Extended Data Buffer Register (TSDBX) Bit Definitions

Bit	Name	Definition
00-03	A18-A21	Command Pointer bits 18-21. When the TSDBX is written, and SSR=1, the data is loaded into bits 18-21 of the internal TSBA register. TSDBX is cleared after TSDB is written and is also cleared by Initialize.
04-06	—	Reserved. Should always be written to 0.
07	BT	Boot Command Bit: When written to 1, with SSR=1, causes the tape to be rewound to BOT, the first tape record to be skipped, and the second record (only the first 512 bytes of it) to be loaded into CPU memory space starting at location 0.

COMMANDS

The functions listed in Table 4-2 make up the Tape Subsystem Command Set. Some commands have various subcommands, termed "modes." The device registers are used to initiate command packet processing and retrieve basic status.

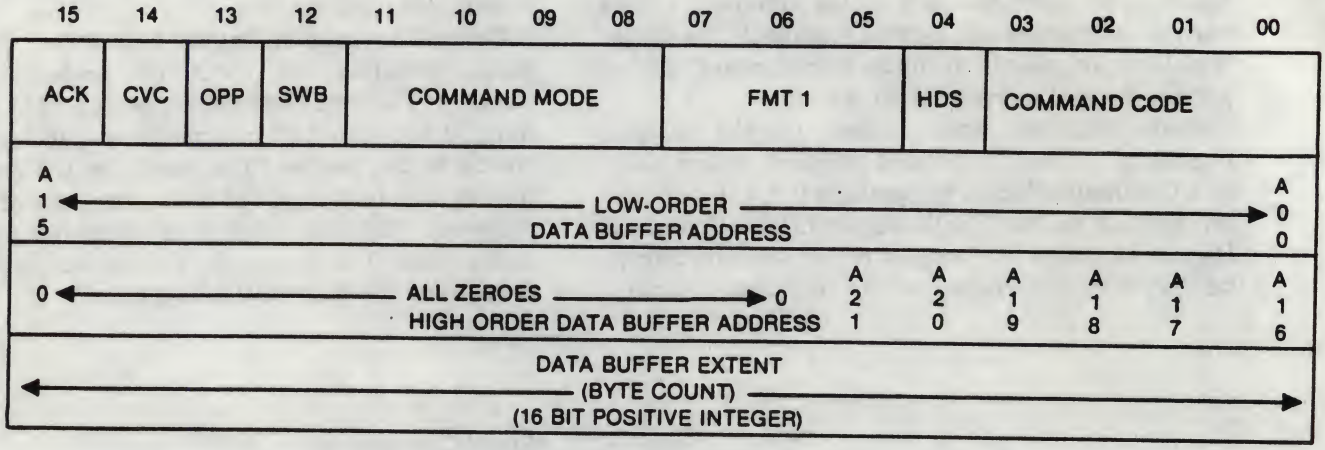
Commands are not written to the coupler registers. Instead, command pointers, which point to a Command Packet somewhere in CPU memory, are written to the TSDB register. The Command Packet instructs the coupler about the function to be performed. These words contain function parameters such as bus address, byte count, record count, and modifier flags.

Before the coupler begins a function, the CPU must assemble the command packet in main memory. The command packet is always four words long, although not all commands use all four of the words in the packet. The words in the command packet may be thought of as the contents of several registers. The first word in a command packet is called the Header-word. Command types are detailed in the following paragraphs.

Table 4-2. Assigned Commands

Command Name	Mode Name/Description
GET STATUS	Get Status (update the message buffer in memory).
READ	Read Next (Forward) Read Previous (Reverse) Reread Previous (Space Reverse, Read Forward or Read Reverse, Space Forward) Reread Next (Space Forward, Read Reverse or Read Forward, Space Reverse)
WRITE CHARACTERISTICS	Load Message Buffer Address and Set Device Characteristics
WRITE	Write Data Write Data Retry (Space Reverse, Erase, Write Data)
POSITION	Space Records Forward Space Records Reverse Skip Tape Marks Forward Skip Tape Marks Reverse Rewind
FORMAT	Write Tape Mark Erase Write Tape Mark Retry (Space Reverse, Erase, Write Tape Mark)
CONTROL	Message Buffer Release Rewind and Unload Clean Tape (handled as a NO-OP) Rewind with Immediate Interrupt (TSV05 only)
INITIALIZE	Coupler/Drive Initialize

Command Packet: Command Word Data Buffer Address, Byte Count



Command Word Bit Definitions

Bit	Name	Definition
0-3	Command Code Field	Used with command mode field to specify tape subsystem commands. See bits 8-11 and Tables 4-3 and 4-4.
4	HDS	High density or streaming select = 1; low density or stop/start = 0.
5-7	Format 1	The following two values are defined in this field. If interrupt enable on, interrupt is generated when SC bit or ready bit (status register) sets. **Bit Values** — **Definition** 000 — Interrupt disable 100 — Interrupt enable
8-11	Command Mode Field	Used with command code field to specify tape subsystem commands. See Tables 4-3 and 4-4.
12-14	Device Dependent Bits	These three bits are implemented as follows: **Bit** — **Name** — **Definition** 14 — CVC — Clear volume check 13 — OPP — opposite (reverse the execution sequence of the reread commands). 12 — SWB, Swap Bytes. SWB = 1 is the industry standard (beginning with an even byte). When SWB = 0, the swapping begins with an odd byte.
15	Acknowledge	This bit is set when a command is issued by the CPU. States that the message buffer is now available to the coupler for any pending or subsequent message packets. Passes control of the message buffer to the coupler.

Table 4-3. Command Code and Mode Field Definitions—Standard

Command Code Field	Command Name	Command Mode Field	Mode Name
00001	Read	0000	Read next (forward)
		0001	Read previous (reverse)
		0010	Reread previous (space reverse, read forward or read reverse, space forward)
		0011	Reread next (space forward, read reverse or read forward, space reverse)
00100	Set Characteristics	0000	Set status message packet address and device characteristics word.
00101	Write	0000	Write data
		0010	Write data retry (space reverse, erase, write data)
01000*	Position	0000*	Space records forward
		0001*	Space records reverse
		0010*	Skip tape marks forward (space files)
		0011*	Skip tape marks reverse (space files)
		0100**	Rewind
01001**	Format	0000	Write tape mark
		0001	Erase (erase 3 inches of tape)
		0010	Write tape mark retry (space reverse, erase, write tape mark)
01010**	Control	0000	Message packet release
		0001	Rewind and unload
		0010	Clean (handled as a NO-OP)
		0100	Rewind with immediate interrupt (TSV05 only)
01011**	Initialize	0000	Drive initialize
01111**	Get status	0000	Get status (End Message Packet)

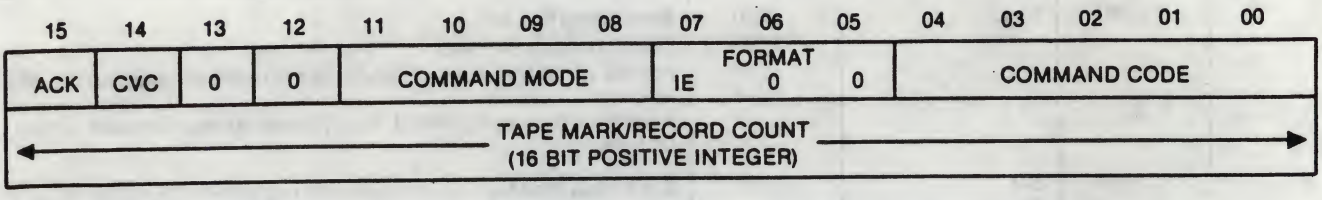
*Two-word command packet
**One-word command packet

Table 4-4. Command Code and Mode Field Definitions—Streaming*

Command Code Field	Command Name	Command Mode Field	Mode Name
10001	Read Streaming	0000	Read next (forward)
		0001	Read previous (reverse)
		0010	Reread previous (space reverse, read forward)
		0011	Reread next (space forward, read reverse)
10101	Write Streaming	0000	Write data
		0010	Write data retry (space reverse, erase, write data)
11000**	Position Streaming	0000	Space records forward
		0001	Space records reverse
		0010	Skip tape marks forward (space files)
		0011	Skip tape marks reverse (space files)
		0100	Rewind
11001***	Format Streaming	0000	Write tape mark
		0001	Erase (erase 3 inches of tape)
		0010	Write tape mark retry (space reverse, erase, write tape mark)

*Jumper JP6 to FDEN, JP7 to FTAD0, and JP8 to FTAD1.
**Two-word command packet
***One-word command packet

TWO-WORD COMMAND PACKET: Command Word and Count



This command causes the tape to space records forward or reverse, skip tape marks forward or reverse, or to rewind to BOT. An exact tape mark/record count must be the second word of the packet for Skip Tape Mark and Space Record commands.

A Space Records operation automatically terminates when a tape mark is traversed. Also, Record Length Short (RLS) is set if the record count was not decremented to zero.

A Skip Tape Marks command terminates when it encounters a double tape mark and the Enable Skip Stop mode is specified (ESS bit set) in the characteristics word. Termination will also occur if a tape mark is the first record off BOT and ESS and ENB bits are set in the characteristics word. Record Length Short (RLS) is set if the record count is not decremented to zero.

A Space Records Reverse or Skip Tape Marks Reverse, which runs into BOT, sets Reverse Into BOT (RIB) and causes a tape status alert termination.

Note

If the tape is positioned between BOT and the first record and a space reverse or skip reverse is done, RIB will set and the residual frame count will equal the specified count in the original command.

SET CHARACTERISTICS COMMAND

Table 4-5 illustrates the Set Characeristics Command and Data Packets. This command informs the coupler of the location and size of the message buffer in the CPU memory and also defines some specific controls required when executing other commands. If successfully completed, this command clears the Need Buffer Address (NBA) bit in TSSR. If the command is rejected because an illegal address was specified, NBA will be set.

The second and third words of the Set Characteristics command give the address of the characteristics data buffer. This buffer must reside on an even address boundary in CPU memory. If bit 0 of the second packet word (low order characteristics data buffer address) or bits 2-15 (extended features disabled) or bits 6-15 (extended features enabled) of the third packet word (high order characteristics data buffer address) are not zero, the command is rejected and no message packet is sent. However, if the IE bit is set in the command packet header word, an interrupt will be generated.

The fourth word of the Set Characteristics Command Packet specifies the number of bytes of the characteristics data buffer. Only values of decimal six, eight, or 10 (extended features enabled) are valid. If a byte count of less than 6 is specified, the command will be rejected. If too large a value is given, the default setting will be used; if extended features are disabled, default is decimal eight; if extended features are enabled, default is decimal 10. Note that only the TSV05 handler supports settings of 6 or 10 bytes. If extended features are disabled and the specified buffer size is six, then the characteristics mode data word portion of the characteristics data packet will not be fetched and the current value of the characteristics mode control bits will be retained. If extended features are enabled and the specified buffer size is either six or eight, the extended characteristics data word will not be fetched and the current values will be retained. If not specified, the characteristics mode data word and extended characteristics data word will default to zero.

Table 4-5. SET CHARACTERISTICS Command Format

SET CHARACTERISTICS Command Packet

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
CTL	DEVICE DEP.			MODE				FORMAT 1			COMMAND				
ACK	CVC	0	0	0	0	0	0	IE	0	0	0	0	1	0	0
A15	LOW ORDER SET CHARACTERISTIC DATA ADDRESS													A01	0
0	HIGH ORDER CHARACTERISTIC DATA ADDRESS							0	(TSV05 ONLY) A21				A18	A17	A16
BUFFER EXTENT (Byte Count) (16-Bit Positive Integer)															

Characteristics Data Packet

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
A15	LOW ORDER MESSAGE BUFFER ADDRESS													A01	0
0	HIGH ORDER MESSAGE BUFFER ADDRESS							0	(TSV05 ONLY) A21				A18	A17	A16
LENGTH OF MESSAGE BUFFER (At Least 14 bytes long) (16-Bit Positive Integer)															
0	RESERVED						0	ESS	ENB	EAI	ERI	0	RESERVED 0	0	0
NOT USED										HDS	NOT USED (TSV05 ONLY)				

The first two words of the set Characteristics data packet give the address of the message buffer in CPU memory. The message packet buffer must reside on an even address boundary in CPU memory. If bit 0 of the first packet word (low order message buffer address) or bits 2-15 (extended features disabled) or bits 6-15 (extended features enabled) of the second packet word (high order message buffer address) are not zero, the command is rejected and no message packet is sent. However, if the IE bit was set in the command packet header word, an interrupt will be generated.

The third word of the data packet specifies the number of bytes of the message buffer. Only values of either decimal 14 or 16 (extended features enabled) are valid. If a byte count of less than 14 is specified, the command will be rejected. If too large a value is given, the default setting will be used. Default is 14 if extended features are disabled; 16 if extended features are enabled. Note that only the TSV05 supports message buffer lengths of 16 bytes.

Table 4-6 defines the control bits in the fourth word of the characteristics data packet—the characteristics mode data word. Table 4-7 defines the control bits in the fifth word—the extended characteristics data word—of the set characteristics data packet. Note that the fifth word is supported only by the TSV05 handler.

Table 4-6. Characteristics Mode Byte Bit Definitions

Bit	Name	Definition
00-03	—	Not Used.
04	ERi	Enable Message Packet Release Interrupts to the CPU: If this bit is 0, interrupts will not be generated when a Message Packet Release command is received by the coupler; upon recognition of the command, only Subsystem Ready (SSR) will be reasserted. If ERI is a 1, an interrupt will be generated.
05	EAi	Enable Attention Interrupts: When this bit is a 0, attention conditions, such as off-line, and on-line will not result in interrupts to the CPU. If set to a 1, interrupts will be generated once the coupler owns the message buffer.
06	ENB	Enable Skip Tape Marks Stop at BOT: This bit is meaningful only if the ESS bit is set. If the drive is at BOT, when a Skip Tape Marks command is issued and the first record seen is a tape mark, then the transport will set LET (XSTAT0) and stop after the first tape mark. If ENB is clear, the drive would not set LET but just count the tape mark and continue.
07	ESS	Enable Skip Tape Marks Stop: When set, the transport stops during a Skip Tape Mark command when a double tape mark (two contiguous tape marks) is detected. If cleared, the Skip Tape Marks command will terminate only on Tape Mark Count Exhausted or if BOT is detected.
08-15	—	Not Used.

Table 4-7. Extended Characteristics Data Word Bit Definitions (TSV05 Only)

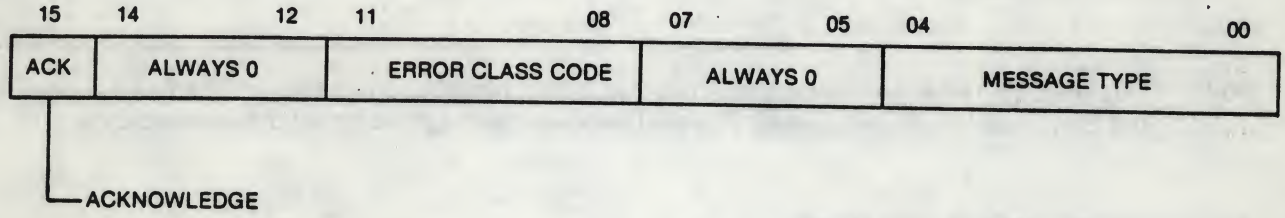
Bit	Name	Description
0-4	—	Not Used.
5	HSD	High-Speed/High Density Select. 0 low density or start/stop 1 high density or stream
6-15	—	Not Used.

MESSAGE PACKET

The message packet format in the message buffer is used for all messages, whether at the end of a command or for an Attention. The message consists of a Header word, a Data Field Length word, a Residual Byte/Record/Tape-Mark Count word, and either four or five extended status registers. Normally, only four extended status registers are provided. The fifth one (XSTAT4) is available only when the extended features function of the coupler is enabled. This feature is supported only by the TSV05.

A summary of the message packet registers is shown at the end of ths section.

Message Packet Header Word



Message Header Word Bit Definitions

Bit	Function

0-4 Termination

Code (TSSR)	Message Type	Definition
0,2	10000	End—no errors
3	10001	Failure to execute
4,5,6,7	10010	Error during execution (1 or more)
1,7	10011	Attention. Interrupt caused by condition specified by error class codes.

5-7 Always Zero.

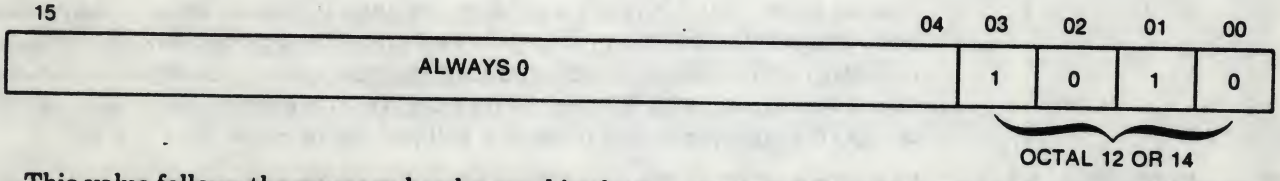
8-11 Error class codes—These bits define the class of failures found in the rest of the message buffer.

MSG Type	Class Code	Definition
ATTN	0000	Drive went on- or off-line (termination code = 10011)
FAIL	0001	Other error (ILC, ILA, NBA) (termination code = 10001)
FAIL	0010	Write lock error no non-executable function (termination code = 10001)

12-14 Always Zero.

15 This bit is used by the coupler to inform the CPU that the command buffer is now available for any pending or subsequent command packets. On an ATTN message, this bit will not be set.

Message Packet Data Field



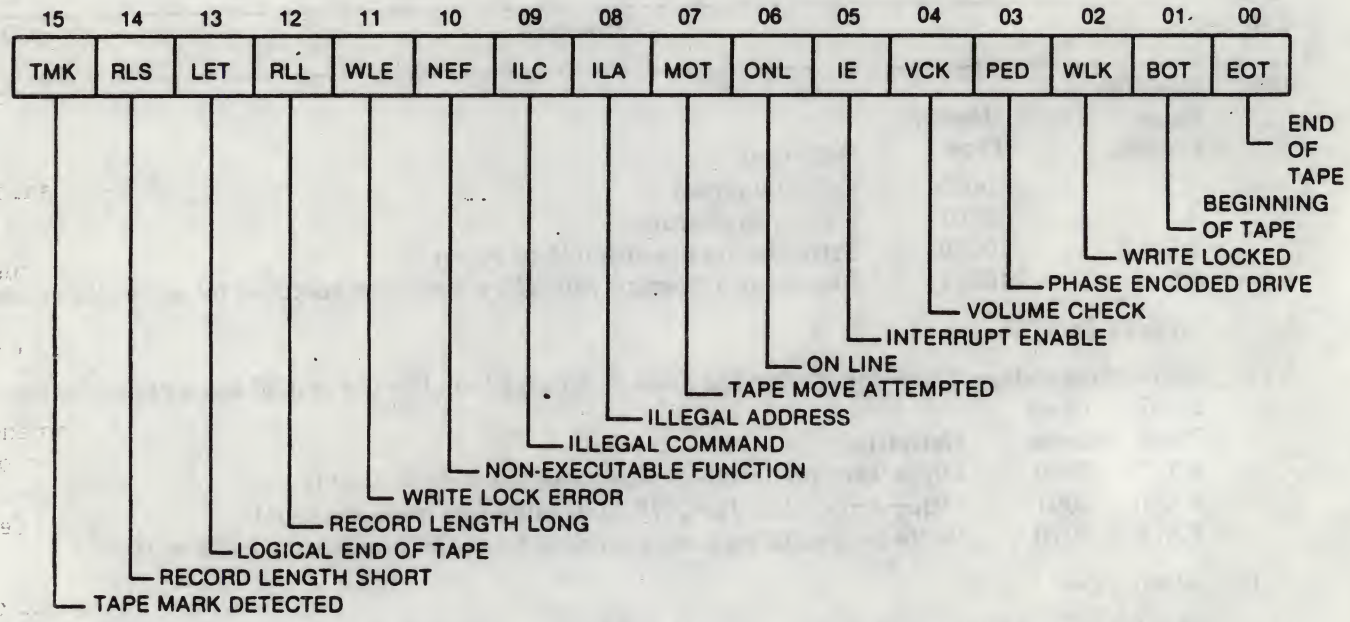
This value follows the message header word in the message packet. This byte count represents the number of bytes remaining in the message packet. These bits always contain an octal 12 or 14 representing five or six words: the residual frame count and four or five status words (as specified through a previous Set Characteristics command).

Residual Frame Count (RBPCR) Word

Word Three in the Message Packet

Bits	Description
00-15	This word contains the octal count of residual bytes, records, tape marks for the Read, Space Records, and Skip Tape Mark commands. The contents are meaningless for all other commands.

Extended Status 0 (XSTAT0) Word

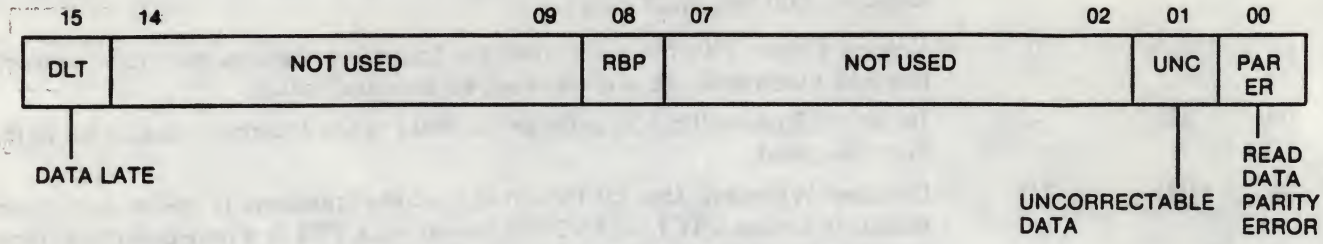


Extended Status 0 Word Bit Definitions

Bit	Name	Termination Code (TC)	Definition
00	EOT	2	End of Tape: This bit is set whenever the tape is positioned at or beyond the end-of-tape reflective strip. It is not reset until the tape passes over the reflective strip in the reverse direction under program control. Subsystem initialization always resets this bit (status on read, TC2 on a write). Manually moving the EOT strip over the EOT sensor will not set or reset the EOT bit.
01	BOT	2/3	Beginning of Tape: When set, this bit indicates that the tape is positioned at the load point as denoted by the BOT reflective strip on the tape. This causes TC2 if reversed to BOT, and TC3 if at BOT when a reverse command occurs.
02	WLK	3	Write Locked: When set, this bit indicates that the mounted tape reel does not have a write enable ring installed. Therefore, the tape is write protected.

03	PED	—	Phase Encoded Drive: When set, this bit indicates that the transport is capable of reading and writing 1600 bit phase encoded data. When 0, this bit indicates 800 bpi, NRZ data.
04	VCK	3	Volume Check: This bit is set when the transport changes state (on-line to off-line and vice versa). It is always set after initialization.
05	IE	—	Interrupt Enable: This bit reflects the state of the Interrupt Enable bit in the last command.
06	ONL	1/3	On-Line: When set, this bit indicates that the transport is on-line and operational. It causes a TC1 on ATTN interrupt or a TC3 or a non-executable function if rejected because the transport was off-line.
07	MOT	—	Motion: Attempted to move tape.
08	ILA	3	Illegal Address: Address contains more than 18 bits or is an odd number.
09	ILC	3	Illegal Command: This bit is set when a command is issued and either its command code field or its command mode field contains codes not supported by the transport.
10	NEF	3	Non-Executable Function: When set, this bit indicates that the command could not be executed due to one of following conditions: • The command specified reverse tape direction but the tape was already positioned at BOT. • A motion command was issued without the Clear Volume Check (CVC) bit being set while the Volume Check bit was set. • A motion command was issued when the transport was off-line. • A write command was issued when the tape did not contain a write enable ring (Write Lock Status [WLS]).
11	WLE	3	Write Lock Error: When set, a TC3 indicates that a write operation was issued but the mounted tape did not contain a write enable ring.
12	RLL	2	Record Length Long: When set, this bit indicates that the record read was longer than the byte count specified.
13	LET	2	Logical End of Tape: This bit is set only on the Skip Tape Marks command under two conditions: when either two contiguous tape marks are detected or when moving off BOT and the first record encountered is a tape mark. This bit will not set unless this mode of termination is enabled through use of the Set Characteristics command. LET will set only in the forward direction.
14	RLS	2	Record Length Short: This bit indicates one of the following: 1) The record length was shorter than the byte count on read operations; 2) a space record operation encountered a tape mark or BOT before the position count was exhausted; 3) a Skip Tape Marks command was terminated by encountering BOT or a double tape mark (if Skip Tape Marks command is enabled (see LET, bit 13) before exhausting the position counter.
15	TMK	2	Tape Mark Detected: This bit is set when a tape mark is detected during a read, space, or skip command and as a result of the Write Tape Mark or Write Tape Mark Retry commands.

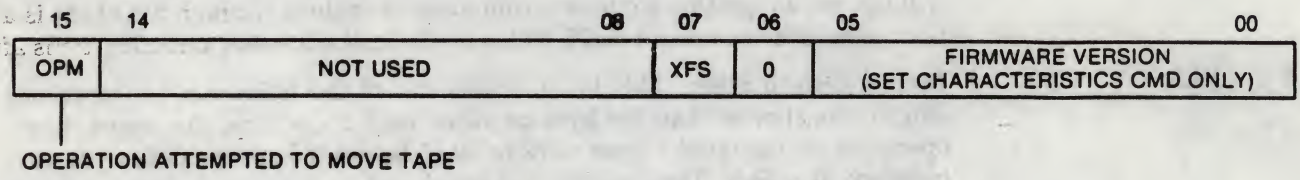
Extended Status 1 (XSTAT1) Word



Extended Status 1 Word Bit Definitions

Bit	Name	Termination Class (TC) Octal Code	Definition
00	PARER	4	Read-Data Parity Error: When set, this bit indicates that the coupler has detected a parity error on the read-data lines coming from the transport.
01	UNC	4	Uncorrectable Data: This bit is set when either a parity error occurs without a corresponding dead track indicator, or more than one dead track occurs in either the preamble or the data field.
02-07	—	—	Always 0.
08	RBP	4	Read Data Parity Error: When set, this bit indicates that the coupler has detected a parity error on the read-data lines coming from the transport (TU80/TSV05).
09-14	—	—	Always 0.
15	DLT	4	Data Late: This bit is set when the FIFO is full on a read or empty on a write. These conditions occur whenever the UNIBUS latency exceeds the transport's data transfer rate for a significant number of transfers.

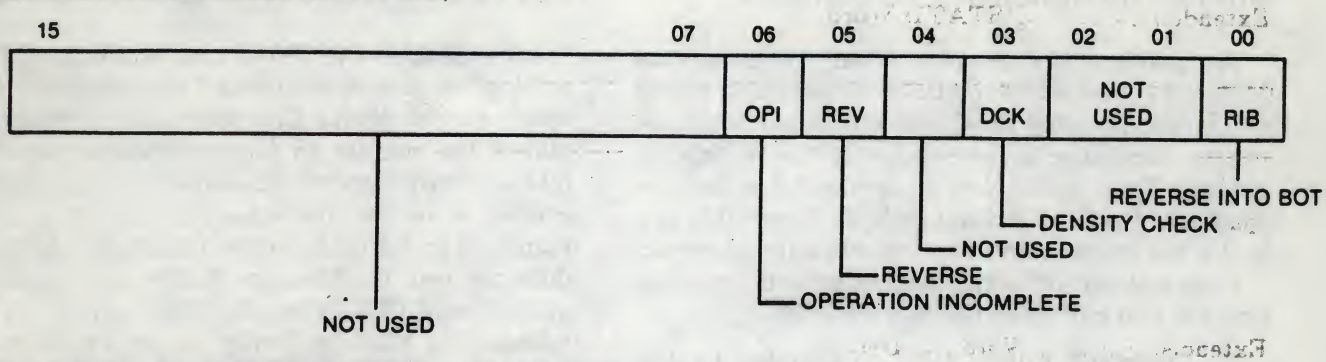
Extended Status 2 (XSTAT2) Word



Extended Status 2 (XSTAT2) Bit Definitions

Bit	Name	Termination Class (TC) Octal Code	Definition
00-05	S		Firmware Version Level: Valid if message is for a Set Characteristics command; zero otherwise.
06	—		Not Used (ALWAYS 0).
07	XFS	S	Extended Features Switch Setting (TSV05 Emulation)
08-14	—		ALWAYS 0.
15	OPM	S	Operation Moved Tape: When set, this bit indicates that the last command caused the tape to be moved.

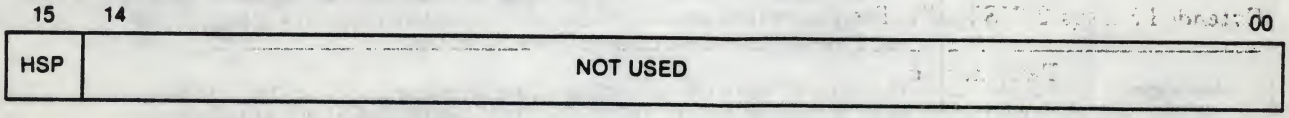
Extended Status 3 (XSTAT3) Word



Extended Status 3 (XSTAT3) Word Bit Definitions

Bit	Name	Termination Code (TC)	Definition
00	RIB	2	Reverse into BOT: This bit is set when a read, space, skip, or reverse command already in progress encounters the BOT marker when moving tape in the reverse direction. Tape motion will be halted at BOT.
01-02	—	—	Not Used.
03	DCK	6	When set, this bit indicates that an invalid Identification Burst (IDB), signifying that the tape was not written in PE, was sensed at BOT. However, the tape can still be read if the IDB is incorrect and the tape is actually written in PE. **Note** *If a tape with a bad IDB is appended, a termination code 6 will not occur until a write is attempted.*
04	—	—	Not Used.
05	REV	—	Reverse: This bit is set when the direction of current tape operation is reverse. For multifunction retry commands, if at least one of the commands is reverse, the bit is set.
06	OPI	6	Operation Incomplete: This bit is set when a read, space, or skip operation has moved 25 feet of tape without detecting any data on the tape. It is also set by a write command when the read head fails to see data transitions after four feet of tape have been moved.
07-15	—	—	Not Used.

Extended Status 4 (XSTAT4) Word—TSV05 Only



Extended Status Register 4 (XSTAT4) Bit Definition (TSV05 Only)

Bit	Name	Termination Class (TC) Octal Code	Definition
0-14	—	—	ALWAYS 0.
15	HSP	S	High Speed: When set, this bit indicates that the transport is operating in high speed mode or high density. When this bit is clear, the transport is operating in low speed mode or low density.

BUFFER OWNERSHIP AND CONTROL

To prevent the coupler from updating the Message Buffer while the CPU is reading it, or the CPU from updating the Command Buffer while the coupler is reading it, the concept of "ownership" is defined. Each buffer may be owned by either the coupler or the CPU, but not by both. Ownership of a buffer can be transferred only by the current owner.

There are four different combinations of transferring the two buffers in the two directions:

1. Command Buffer: CPU to Coupler, by the CPU.
2. Command Buffer: Coupler to CPU, by the Coupler.
3. Message Buffer: CPU to Coupler, by the CPU.
4. Message Buffer: Coupler to CPU, by the Coupler.

Table 4-8 describes the buffer transfer operations.

A Subsystem Initialize aborts any current operation and gives ownership of both the Command Buffer and the Message Buffer to the CPU.

BUFFER CONTROL ON ATTENTIONS (ATTN)

An Attention (ATTN) is enabled by the CPU by setting up the appropriate Characteristics Mode word on the Write Characteristics command. It allows the coupler to flag exceptional conditions (change in transport on-line/off-line status) when the coupler is in the Idle state (not executing a command). If an ATTN condition occurs and the coupler does not own the Message Buffer, the coupler will queue the ATTN internally. Then, when the CPU releases the Message Buffer on the next command (with the ACK bit set), the coupler will output the ATTN message with the ACK bit 0 in the message header word to indicate that the command was lost (except for the transference of ownership of the Message Buffer to the coupler). In this case, the coupler refuses to accept ownership of the Command Buffer. The CPU will then still own the Command Buffer (because the coupler did not accept the command) and will also own the Message Buffer now filled with an ATTN message. If the CPU still wants to do the ignored command, the CPU must reissue the command (with the ACK bit set).

Table 4-8. Buffer Ownership Transfers

Buffer	Direction	Transfer Method
Command Buffer	CPU to Coupler	The CPU transfers ownership of the Command Buffer to the coupler by writing the address of the Command Buffer into the TSDB register. This clears the SSR bit in TSSR.
Command Buffer	Coupler to CPU	The coupler transfers ownership of the Command Buffer back to the CPU by depositing a Message Packet (in the Message Buffer) that has the Acknowledge (ACK) bit set in the message header word. After the message is deposited by the coupler, it sets the SSR bit in TSSR to indicate that the message is in the Message Buffer. If the message does not contain the ACK bit set, the CPU will know that the coupler did not see the last Command Buffer and that the CPU still owns the Command Buffer. The command may be reissued by the CPU (with the ACK bit set).
Message Buffer	CPU to Coupler	The CPU transfers ownership of the Message Buffer to the coupler by setting the ACK bit in the Command Buffer and then initiating the command by writing into TSDB. If the Command Buffer does not contain the ACK bit, the coupler will know that the CPU did not see the last message buffer and the coupler still owns it. The coupler, in response to the CPU writing into TSDB, will set SSR and perform an Interrupt (if the IE bit is set) without sending out a message, since it does not own the buffer.
Message Buffer	Coupler to CPU	The coupler transfers ownership of the Message Buffer to the CPU by writing the Message Buffer and setting the SSR bit. This can happen at one of two times: 1. At the end of a command, or 2. By outputting an Attention (ATTN) message. In this case, SSR will already be 1 because an ATTN only happens when the coupler is inactive. So the coupler clears SSR, outputs the message, then sets SSR again (and interrupts if the IE bit was set on the Message Buffer Release command that gave control of the Message Buffer to the coupler). Note that for an ATTN to occur, the EAI bit must have been set in the previous Write Characteristics command.

During normal command processing, the ownership of both buffers passes simultaneously, first from CPU to coupler (at the start of command processing, when the CPU writes a Command Pointer into the TSDB register), and then from coupler to CPU (upon completion of the command) when the coupler sets SSR in the TSSR.

Now consider the case in which the CPU wants to be notified of a change in status while the coupler is inactive for a long period of time. To accomplish this, the coupler must own the Message Buffer for that entire period of time. Normally, the coupler gives up ownership of the Message Buffer at the end of a command. However, for enabling Attention messages, ownership of the Message Buffer is transferred to the coupler via the Message Buffer Release command. This is a special command that tells the coupler not to give ownership of the Message Buffer back to the CPU at the end of the command.

The coupler does not output a message at the end of this command, but just updates the TSSR register (with the SSR bit set) and interrupts (if the IE bit was set in the command and such an interrupt was enabled by the ERI bit in the previous Write Characteristics command). The coupler then maintains ownership of the Message Buffer until an ATTN condition is seen and then immediately clears SSR, outputs the ATTN message (with the ACK bit not set since the coupler is not responding to a command), and then sets SSR and interrupts the CPU (if the IE bit was set on the Message Buffer Release command). In this condition, the CPU owns the Command Buffer and the Coupler owns the Message Buffer. If the coupler outputs an Attention message, ownership of the Message Buffer is passed to the CPU. At that time the system is back to the state of the CPU owning both buffers. Another ATTN will not be done until the CPU does a command with the ACK bit set to release ownership of the Message Buffer containing the ATTN message.

If the CPU has done a Message Buffer Release command, and wants to do another command but has not received an ATTN from the coupler (so that the coupler still owns the Message Buffer from the Message Buffer Release command), the CPU can do a command without the ACK bit set in the command buffer. At the time the command is issued, the CPU does not own the Message Buffer so the CPU cannot release the Message Buffer. If the CPU does set the ACK bit, nothing will happen except that the CPU might miss an ATTN if the coupler was sending out an ATTN message at the same time that the CPU was issuing the command.

It is possible that the CPU may attempt to initiate a new command at or near the same time that the coupler attempts to output an Attention message. (The command must not have the ACK bit set since the CPU does not own the Message Buffer.) If the CPU writes the TSDB register while SSR is clear during an ATTN, the Register Modification Refused (RMR) error bit will be set and that command will be ignored. The ATTN message will not have the ACK bit set since the coupler does not own the Command Buffer. Note that RMR may set in this way on a bug-free system. All other settings of RMR indicate a software bug (the CPU tried to do a command before the previous command was finished). If the CPU command was lost because the coupler was outputting an ATTN message, Volume Check (VCK) and Interrupt Enable (IE) are not updated. If the CPU command was rejected (illegal command, etc.) and not ignored, VCK and IE are updated to the start of the rejected command.

MISCELLANEOUS STATUS AND ERROR HANDLING

The following points should be noted in regard to status and error handling:

1. Error bits in the TSSR register (SC and RMR) are cleared by successfully loading a command pointer into the TSDB register and by successfully depositing an END message.

2. All commands clear the internal copy of each error bit in the Extended Status registers. Therefore, a Get Status command will not return the error bits as set up by a previous tape operation.

3. A read operation which encounters a tape mark will not transfer any data and will give a Tape Status Alert termination. The Tape Mark and Record Length Short status bits will be set, and the RBPCR word in the message buffer will contain the original byte count as specified in the command.

4. A Space Records operation will automatically terminate when a tape mark is traversed, and the TMK status bit will be set. Also, Record Length Short (RLS) will be set if the record count was not decremented to zero.

5. A Skip Tape Marks operation will automatically terminate when two consecutive tape marks are encountered and the "Enable Skip Stop" (ESS) mode is enabled via the Write Characteristics command. Record Length Short (RLS) will be set if the count was not decremented to zero. The same is also true if a tape mark is the first record off BOT and both the ESS and ENB bits were set in the previous Write Characteristics data word.

6. Every Write, Write Retry, Write Tape Mark, Write Tape Mark Retry, and Erase command which is executed at or beyond the EOT marker will result in a Tape Status Alert termination. The internal EOT status bit will remain set until logically passed over in the reverse direction (Rewind, Reverse Read,

Reverse Space, etc.). The EOT status bit is not specifically identified with a particular record.

7. A Read Reverse, Space Reverse, Reverse or Skip Tape Marks Reverse command which encounters BOT after the operation is underway will result in a Tape Status Alert termination (the RIB status bit will be set).

8. If a Read Reverse, Space Records Reverse, or Skip Tape Marks Reverse command is issued while the tape is already at BOT, a Function Reject (NEF-Non-Executable Function) status will be returned.

9. When a normal rewind command is issued, the termination message and interrupt will not occur until the tape reaches BOT and has stopped. If the tape is already at BOT when the command is issued, the transport will still be commanded to rewind to make sure the tape is properly positioned.

10. When a Rewind with Immediate Interrupt command is issued, the coupler commands the transport to rewind, checks for proper status, and then issues an Interrupt and END message for normal termination. If a new tape motion command is issued to a rewinding unit, the coupler will wait until the tape has been rewound to BOT before proceeding with the new command. During execution of a Rewind with Immediate Interrupt, the Motion (MOT) bit in XSTAT0 will be set if a Get Status command is performed.

11. Any write function issued at BOT (including Erase) which results in the Density Check bit (DCK) being set will cause a termination of that command with a TSSR Termination Class code of 6 set to indicate an unrecoverable error. Normally, a write function causes the PE Identification (ID) burst to be written off BOT, and the coupler checks for the appropriate signal from the transport. Therefore, if DCK is set on a write off BOT, a serious transport or coupler problem exists.

12. If a Density Check condition is detected during a read, space or skip function, the DCK bit will be set but the operation will not be aborted. If DCK is the only error status bit set during the operation, normal termination will be reported. This allows tapes with good data but bad density check (ID) areas to be read. If, in fact, a tape of the wrong density has been mounted, other errors will be reported and will stop the operation.

13. Note that if you begin reading a tape, get a Density Check with no other errors, and then append data to the tape, the write command will get a Termination Class code of 6, indicating that tape position is lost, because Density Check will remain set. The whole tape should be copied over so that drives that depend on the ID burst will be able to read the tape.

14. Certain failures can result in no interrupt even though the specified command had Interrupt Enable set. These failures include NXM (Non-Existent Memory Error), since the failure could have occurred before the Interrupt Enable bit was fetched from the command packet.

15. The software should defend against unexpected interrupts, since the tape subsystem may not be useable, but the software should still not crash.

BUS REGISTERS

MSB LSB

BIT POSITION	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
TSBA (R/O)	A15	A14	A13	A12	A11	A10	A09	A08	A07	A06	A05	A04	A03	A02	A01	A00
TSDB (W/O)	P15	P14	P13	P12	P11	P10	P09	P08	P07	P06	P05	P04	P03	P02	P17	P16
TSSR (R/W)	SC	0	SCE	RMR	NXM	NBA	A17	A16	SSR	OFL	FC1	FC0	TC2	TC1	TC0	0
TSDBX (W/O)	BT	0	0	0	P21	P20	P19	P18	MSDBX P<21:18> only available when Extended Features are enabled (TSV05 only)							

BUS REGISTERS

Figure 4-3. Message and Command Packets
Register Summary

COMMAND PACKETS

Four-Word Command Packet: Command Word Data Buffer Address, Byte Count

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word 1	ACK	CVC	OPP	SWB	COMMAND MODE					FMT 1		HDS	COMMAND CODE			
Word 2	LOW-ORDER DATA BUFFER ADDRESS														A 0 0	
Word 3	ALL ZEROES								0	HIGH ORDER DATA BUFFER ADDRESS			A 21	A 20	A 19	A 16
Word 4	DATA BUFFER EXTENT (BYTE COUNT) (16 BIT POSITIVE INTEGER)															

Two-Word Command Packet: Command Word and Count

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word 1	ACK	CVC	0	0	COMMAND MODE				IE	FORMAT 0	0	COMMAND CODE				
Word 2	TAPE MARK/RECORD COUNT (16 BIT POSITIVE INTEGER)															

Set Characteristics Command Packet

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word 1	CTL / ACK	DEVICE DEP / CVC	0	0	MODE 0		0	0	IE	FORMAT 1 0	0	COMMAND 0	0	1	0	0
Word 2	A15	LOW ORDER SET CHARACTERISTIC DATA ADDRESS													A01	0
Word 3	0	HIGH ORDER CHARACTERISTIC DATA ADDRESS						0	A21	(TSV05 ONLY)			A18	A17	A16	
Word 4	BUFFER EXTENT (Byte Count) (16-Bit Positive Integer)															

Characteristics Data Packet

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Word 1	A15	LOW ORDER MESSAGE BUFFER ADDRESS													A01	0
Word 2	0	HIGH ORDER MESSAGE BUFFER ADDRESS						0	A21	(TSV05 ONLY)			A18	A17	A16	
Word 3	LENGTH OF MESSAGE BUFFER (At Least 14 bytes long) (16-Bit Positive Integer)															
Word 4	RESERVED 0							0	ESS	ENB	EAI	ERI	RESERVED 0	0	0	0
	NOT USED										HDS	NOT USED (TSV05 ONLY)				

Figure 4-3 (continued). Message and Command Packets Register Summary

MESSAGE PACKET

MESSAGE PACKET HEADER WORD (STATUS ADDRESS

15	14	12	11	08	07	04	00
ACK	ALWAYS 0		ERROR CLASS CODE		ALWAYS 0		MESSAGE TYPE

MESSAGE PACKET DATA FIELD

15	04	03	02	01	00
ALWAYS 0		1	0	1	0

RESIDUAL FRAME COUNT (RBPCR WORD) (STATUS ADD + 4)

15	00
RESIDUAL FRAME COUNT WORD	

XSTAT0

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
TMK	RLS	LET	RLL	WLE	NEF	ILL	ILA	MOT	ONL	IE	VCK	PEO	WLK	BOT	EOT

XSTAT1

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
DLT	///	COR	0	0	0	0	RBP	0	0	0	0	0	0	UNC	0

XSTAT2

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
OPM	0	0	0	0	0	0	0	RL7	RL6	RL5	RL4	RL3	RL2	RL1	RL0

XSTAT3

15	08	07	06	05	04	03	02	01	00
MICRO DIAGNOSTIC ERROR CODE		0	OPI	REV	0	0	0	0	0

XSTAT4

15	14	13	12	11	10	09	08	07	00
HSP	RCS	0	0	0	0	0	0	WRITE RETRY COUNT	

Figure 4-3 (continued). Message and Command Packets Register Summary